Primary 4
Teacher Edition
Unit 3

Science Term 2

Part 1

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Teacher Edition

Science Term 2

Part 1

Discovery Education, Inc.
4350 Congress Street, Suite 700
Charlotte, NC 28209
800-323-9084
Education_Info@DiscoveryEd.com

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FOREWORD

This is a pivotal time in the history of the Ministry of Education and Technical Education (MOETE) in Egypt. We are embarking on the transformation of Egypt's K-12 education system. We started in September 2018 with the rollout of KG1, KG2 and Primary 1. In 2021 we have rolled out Primary 4, and we will continue with the rollout until 2030. We are transforming the way in which students learn to prepare Egypt's youth to succeed in a future world that we cannot entirely imagine.

MOETE is very proud to present this new series of textbooks, with the accompanying digital learning materials that captures its vision of the transformation journey. This is the result of much consultation, much thought and a lot of work. We have drawn on the best expertise and experience from national and international organizations and education professionals to support us in translating our vision into an innovative national curriculum framework and exciting and inspiring print and digital learning materials.

The MOETE extends its deep appreciation to its own "Center for Curriculum and Instructional Materials Development" (CCIMD) and specifically, the CCIMD Director and her amazing team. MOETE is also very grateful to the minister's senior advisors and to our partners including "Discovery Education," "National Geographic Learning" "Nahdet Masr," "Longman Egypt," UNICEF, UNESCO, and WB, who, collectively, supported the development of Egypt's national curriculum framework. I also thank the Egyptian Faculty of Education professors who participated in reviewing the national curriculum framework. Finally, I thank each and every MOETE administrator in all MOETE sectors as well as the MOETE subject counselors who participated in the process.

This transformation of Egypt's education system would not have been possible without the significant support of Egypt's current president, His Excellency President Abdel Fattah el-Sisi. Overhauling the education system is part of the president's vision of 'rebuilding the Egyptian citizen' and it is closely coordinated with the ministries of Higher Education & Scientific Research, Culture, and Youth & Sports. Education 2.0 is only a part in a bigger national effort to propel Egypt to the ranks of developed countries and to ensure a great future to all of its citizens.

Words from the Minister of Education & Technical Education

It is my great pleasure to celebrate this extraordinary moment in the history of Egypt where we continue to launch a new education system designed to prepare a new Egyptian citizen proud of his Egyptian, Arab and African roots — a new citizen who is innovative, a critical thinker, able to understand and accept differences, competent in knowledge and life skills, able to learn for life and able to compete globally.

Egypt chose to invest in its new generations through building a transformative and modern education system consistent with international quality benchmarks. The new education system is designed to help our children and grandchildren enjoy a better future and to propel Egypt to the ranks of advanced countries in the near future.

The fulfillment of the Egyptian dream of transformation is indeed a joint responsibility among all of us; governmental institutions, parents, civil society, private sector and media. Here, I would like to acknowledge the critical role of our beloved teachers who are the role models for our children and who are the cornerstone of the intended transformation.

I ask everyone of us to join hands towards this noble goal of transforming Egypt through education in order to restore Egyptian excellence, leadership and great civilization.

My warmest regards to our children who will begin this journey and my deepest respect and gratitude to our great teachers.

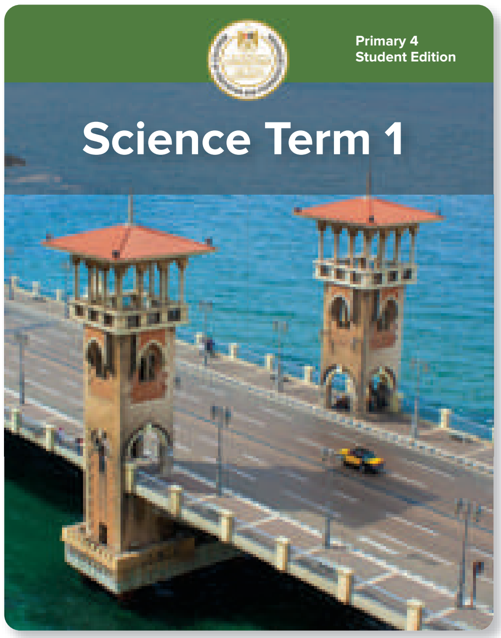
Dr. Tarek Galal Shawki

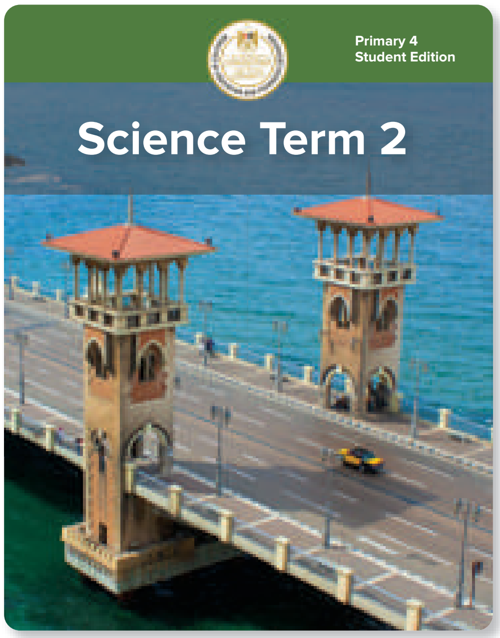
Minister of Education & Technical Education

Welcome to Primary 4 Science Techbook!

Students all over the world are natural explorers, filled with curiosity and innovative ideas. Science helps all of us understand and make sense of the world. Scientific reasoning helps students search for solutions to real-world challenges and to ask new questions as learners and thinkers. As you read the new Primary 4 student and teacher instructional resources, keep a few things in mind:

- The Primary 1 through Primary 3 multidisciplinary curriculum, Discover, implemented across Egypt starting from 2018 to 2020, helped lay a foundation for young students to inquire, observe, and think like scientists.
- The Primary 4 science content is more challenging than ever before, however students are aided by their experience in the new KG through Primary 3 curriculum. To help all students reach the challenging expectations in Preparatory and Secondary years, Primary 4 Science Techbook offers more opportunities for deeper learning, more opportunities for hands-on investigation, and more practice using the skills necessary to think, observe, analyze, and evaluate like scientists.
- The Primary 4 science curriculum is called a Techbook™. The Techbook is more than just print. It is a 21st-century instructional resource designed to inspire and empower all students through digital and print learning. The program has content in both print and digital locations so that students can learn whether they have access to the print book or digital version.





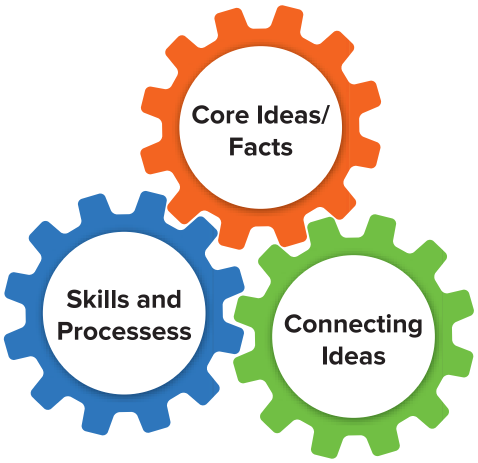
Program Philosophy

The Primary 4 Science Techbook was designed and written to align to the Ministry of Education Primary 4 science learning standards. These standards are internationally benchmarked, providing students in Egypt with a rigorous framework of learning targets.

The first step in building the Primary 4 framework was the adoption of new standards and specific grade-level indicators for learning in physical science, life science, earth and space science, environmental science, and engineering design and processes. These standards are integrated across three dimensions:

- disciplinary core ideas (such as energy transformations or the structure of cells),
- science skills and processes (such as asking questions to plan investigations, developing models, communicating scientific information), and
- connecting ideas that carry over across disciplines (such as cause and effect, systems, patterns).

This approach to teaching science is referred to as three-dimensional learning. Science is much more than an accumulation of facts; it is an intersection of three dimensions: facts, skills and processes, and connecting ideas.



- Core ideas have broad importance, are key organizing concepts, and provide tools for complex ideas.
- Skills and processes combine the behaviors that scientists engage in and the key engineering practices that they use.
- Connecting ideas link the different domains of Science.

The intersection of these three dimensions provides the foundation for the scientific content in Primary 4. The structure of Primary 4 Science Techbook also embodies the Ministry's shifts in the Framework for Education 2.0., specifically focusing on:

- student-centered learning;
- providing opportunities for authentic investigation by prioritizing hands-on learning; and
- creating globally prepared students by integrating career, technology, entrepreneurship, and life skills.

Student-Centered Learning: Wonder • Learn • Share

Students are at the heart of Primary 4 science instruction. Students act as scientists and engineers to investigate problems and construct solutions. Students conduct research and develop scientific explanations for phenomena. Students build and test prototypes and determine the best solutions based on the collection and analysis of data. By exploring real-world situations and articulating original questions with teacher support, students actively construct scientific knowledge and identify ways to improve and extend human capabilities.

To help drive a student-centered approach to learning, Primary 4 Science Techbook is organized by the Wonder-Learn-Share sequence. This sequence may be a change from how science has been taught previously, but having students think about the natural phenomena they are investigating before they dig into the learning helps them retain more knowledge and develop the skills and disposition of a scientist and a learned citizen.

Wonder starts off every concept by igniting natural curiosity with relatable content that inspires students to ask the questions they want to explore about the inner workings of the world around us.

Learn helps students find answers to the questions posed in Wonder. Students explore, observe, predict, and investigate the phenomena of science through rich texts, Hands-On Investigations and experiments, and engaging interactive resources.

Share requires students to summarize their learning with their peers and teacher. Students develop solutions to real-world challenges and write scientific explanations that include their evidence-based reasoning.

Hands-On Learning: All Students as Experimental Scientists

Hands-On Investigations (HOIs) are a foundational component of Primary 4 Science Techbook. Hands-On Investigations require students to investigate scientific ideas, build scientific understanding through observation, and practice the skills of doing science that develop their knowledge and effective solutions.

A materials list for each HOI is included in multiple locations: at point-of-use in digital, in the print Teacher Edition, and in the print Student Edition. Science materials were chosen to be easily accessible and mostly familiar to both students and teachers. Each materials list should be reviewed well in advance of the date of classroom use to ensure all materials are available. To assist teachers in familiarizing themselves with the HOIs, a series of teacher support instructional videos are included with this product.

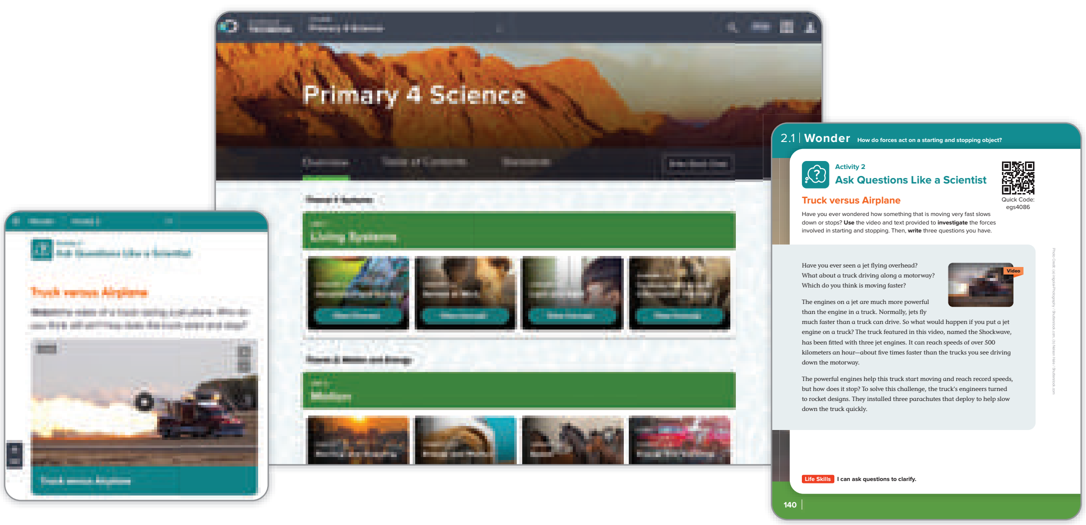
Globally Prepared Students: Action-Packed, Real-World Challenges

To prepare students with the skills they need to succeed in an interconnected, global society, Primary 4 Science Techbook integrates skills and concepts from career fields, technology, entrepreneurship, and life skills.

- **Careers:** The study of science, technology, engineering, and math (STEM) fields and pathways to STEM careers provides an ongoing emphasis on careers and real-world applications for learning.
- **Technology:** Students examine the structure and function of individual technologies as well as both the role of technology in society and the role of society in the development and use of technology.
- **Entrepreneurship:** In the Share portion of each concept, students encounter the skills of entrepreneurship, including discovering opportunities, generating creative ideas, setting a vision for transforming ideas into valuable activities, and using ethical and sustainable thinking.
- **Life Skills:** Building on introductions made through Primary 3, Primary 4 Science Techbook highlights opportunities to apply and practice the life skills throughout the instructional sequence.

Course Structure

The Primary 4 Science Techbook is a comprehensive teaching and learning package, featuring an easy-to-use digital platform, an interactive print Student Edition, and a print Teacher Edition. This print Teacher Edition provides guidance for teachers to implement high-quality, three-dimensional learning through Hands-On Investigations, lab investigations, and print and digital assets. This flexibility of resources supports the many variations of classroom settings, so teachers can implement standards-based lessons no matter their particular situation. The digital and print resources work seamlessly together, allowing students to both express thinking on paper and explore ideas and concepts digitally.



Themes

The Primary 4 Science Techbook is organized into four themes that form the structure of science courses from Primary 4 through Primary 6. In each grade, the theme is studied through an applied topic, represented by units within this curricular resource. Each unit launches with an engaging, real-world anchor phenomenon to captivate students. The anchor phenomena will inspire students to ask questions they themselves want to investigate. At the end of the learning progression, students solve problems related to the anchor phenomenon with the culminating unit project. The themes and Primary 4 units are as follows:

Theme	Primary 4 Unit
Systems	Living Systems
Matter and Energy	Motion
Protecting Our Planet	Energy and Fuels
Change and Stability	Shifting Surfaces

Concepts

Within each unit there are three to four concepts, which are the heart of the learning process. The concept helps students understand the anchor phenomena with the development of learning standards through the use of text, multimedia, Hands-On Investigations, and STEM projects. Every concept:

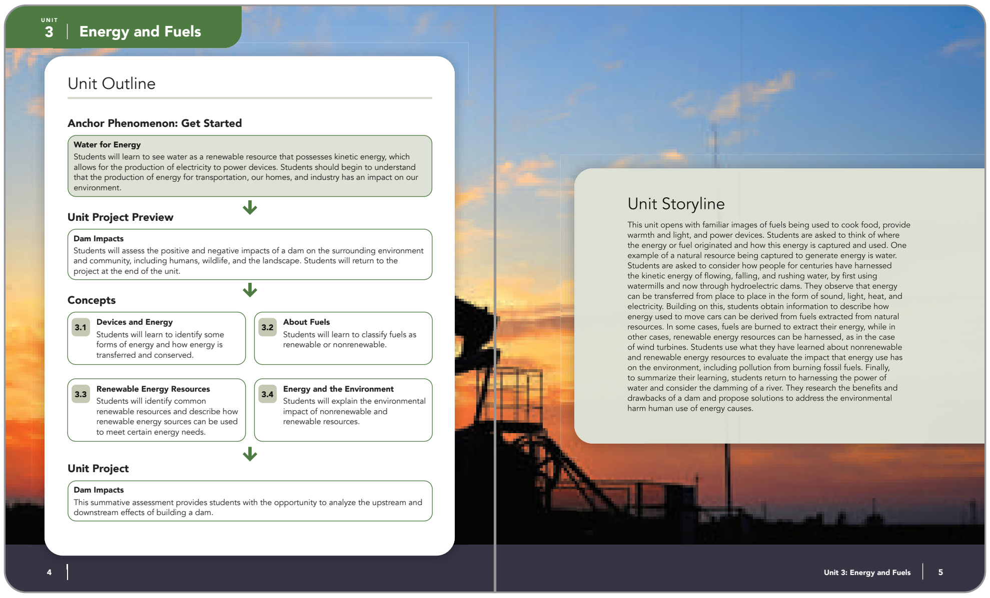
- launches with an investigative phenomenon and a related Can You Explain? question;
- provides multiple pathways for students to demonstrate their learning, including the creation of scientific explanations in the claim, evidence, reasoning format;
- encourages STEM career exploration; and
- includes activities that connect to the unit project, allowing students to synthesize and develop a deeper understanding of the concept objectives.

Activities

Each concept is comprised of a series of activities or learning experiences. The Recommended Pathway clearly outlines the sequence and duration of each learning activity. Activities vary in length and many daily lessons include several activities that are woven together to create rigorous learning experiences for students.

Unit and Concept Overviews

Each unit in the Teacher Edition begins with a storyline. The storyline summarizes the big picture of how the unit anchor phenomena, supporting concepts, and culminating unit project interact with and build on each other. Each concept provides pacing directions, differentiation, and STEM and entrepreneurship connections.



UNIT 3 | Energy and Fuels

Unit Outline

Anchor Phenomenon: Get Started

Water for Energy
Students will learn to see water as a renewable resource that possesses kinetic energy, which allows for the production of electricity to power devices. Students should begin to understand that the production of energy for transportation, our homes, and industry has an impact on our environment.

Unit Project Preview

Dam Impacts
Students will assess the positive and negative impacts of a dam on the surrounding environment and community, including humans, wildlife, and the landscape. Students will return to the project at the end of the unit.

Concepts

3.1 **Devices and Energy**
Students will learn to identify some forms of energy and how energy is transferred and conserved.

3.2 **About Fuels**
Students will learn to classify fuels as renewable or nonrenewable.

3.3 **Renewable Energy Resources**
Students will identify common renewable resources and describe how renewable energy sources can be used to meet certain energy needs.

3.4 **Energy and the Environment**
Students will explain the environmental impact of nonrenewable and renewable resources.

Unit Project

Dam Impacts
This summative assessment provides students with the opportunity to analyze the upstream and downstream effects of building a dam.

4

Unit Storyline

This unit opens with familiar images of fuels being used to cook food, provide warmth and light, and power devices. Students are asked to think of where the energy or fuel originated and how this energy is captured and used. One example of a natural resource being captured to generate energy is water. Students are asked to consider how people for centuries have harnessed the kinetic energy of flowing, falling, and rushing water, by first using watermills and now through hydroelectric dams. They observe that energy can be transferred from place to place in the form of sound, light, heat, and electricity. Building on this, students obtain information to describe how energy used to move cars can be derived from fuels extracted from natural resources. In some cases, fuels are burned to extract their energy, while in other cases, renewable energy resources can be harnessed, as in the case of wind turbines. Students use what they have learned about nonrenewable and renewable energy resources to evaluate the impact that energy use has on the environment, including pollution from burning fossil fuels. Finally, to summarize their learning, students return to harnessing the power of water and consider the damming of a river. They research the benefits and drawbacks of a dam and propose solutions to address the environmental harm human use of energy causes.

Unit 3: Energy and Fuels | 5

Approach

Using Phenomena to Spark Curiosity and Learning

Throughout this course, real-world and engaging phenomena are used to pique students' curiosity.

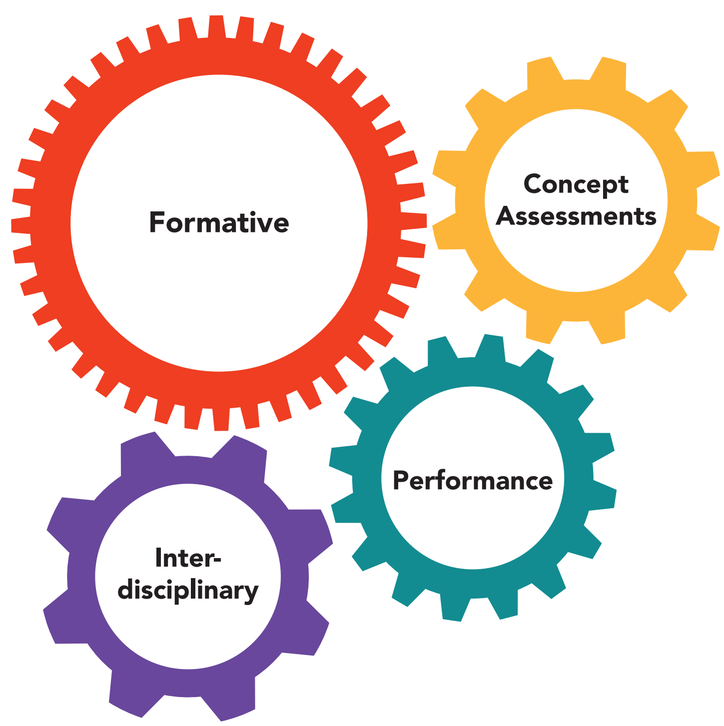
This phenomenon-based instructional approach shifts the focus from learning about a topic to uncovering why or how a scientific event happened. At the unit level, an anchor phenomenon sets a purpose for learning across concepts. A unit project, highlighted at the beginning of each unit, expects students to return to the anchor phenomenon at the end of the unit. The unit project summarizes student learning across the unit storyline and serves as a summative assessment of three-dimensional learning.

Each concept also begins with a smaller, real-world investigative phenomenon to inspire students to uncover the scientific principles behind the phenomenon. Students dive into the remainder of the content using a variety of scientific practices, including asking questions, observing, analyzing information, and designing solutions. Students return to the investigative phenomenon at the end of each concept, using the scientific skills and practices to provide evidence and reasoning for their claims.

Approach to Assessment

Assessments are an integral part of instruction that provide evidence of proficiency and student success. By using a variety of assessment formats and data sources, a comprehensive program can serve three distinct functions:

- Monitor students' progress and provide feedback to promote student learning
- Make instructional decisions to modify teaching to facilitate student learning
- Evaluate students' achievement to summarize and report students' demonstrated understanding at a particular point in time

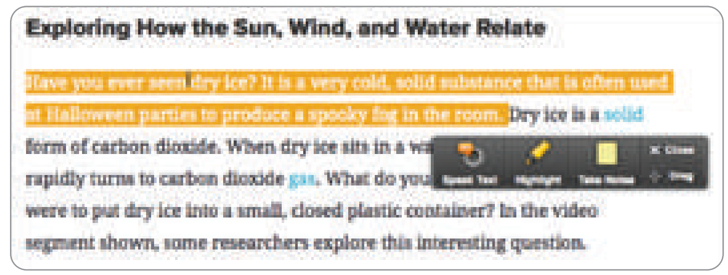


In the Primary 4 Science Techbook, assessments are embedded throughout as formative, summative, performance-based (project-based), and interdisciplinary projects.

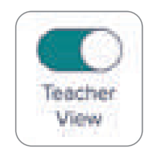
Science Techbook Features

Tools and Text Features

The tools within every concept in Primary 4 Science Techbook support differentiation for the core instructional activities and cater to the different learning preferences of diverse learners. In the digital core interactive text, students and teachers can have text read aloud, highlight important information, or annotate content with sticky notes. Select the text in any concept, and a reader tool will appear.



Digital Teacher Materials



In digital Primary 4 Science Techbook, teachers can not only easily see the student view of content, but they can also access additional support using the Teacher Presentation Mode toggle. Teacher notes, featuring both the instructional focus and recommended strategy, are included with each activity and are visible to teachers only. In addition, teachers can view sample responses to student questions, and Hands-On Investigations include a teacher's guide with detailed procedural notes.

Flexible Learning Environment

With the evolution of technology, today's students expect information to be available differently than previous generations. Students are accessing information in shorter segments, streaming digital shows, and reading posts through social media. The Primary 4 Science Techbook taps into students' preferences of consuming digital content and provides highly engaging, standards-based content guaranteed to inspire and encourage students to delve deeper into science.

Through every step of the learning cycle, the Primary 4 Science Techbook features diverse and rich multimedia resources: video, images, audio, interactives, virtual labs, online models, animations, rich informational text, and more. Engaging science content blends entertainment with education to motivate students to investigate real-world phenomena. Virtual labs and online models allow students to quickly manipulate variables to test their ideas in an online environment.

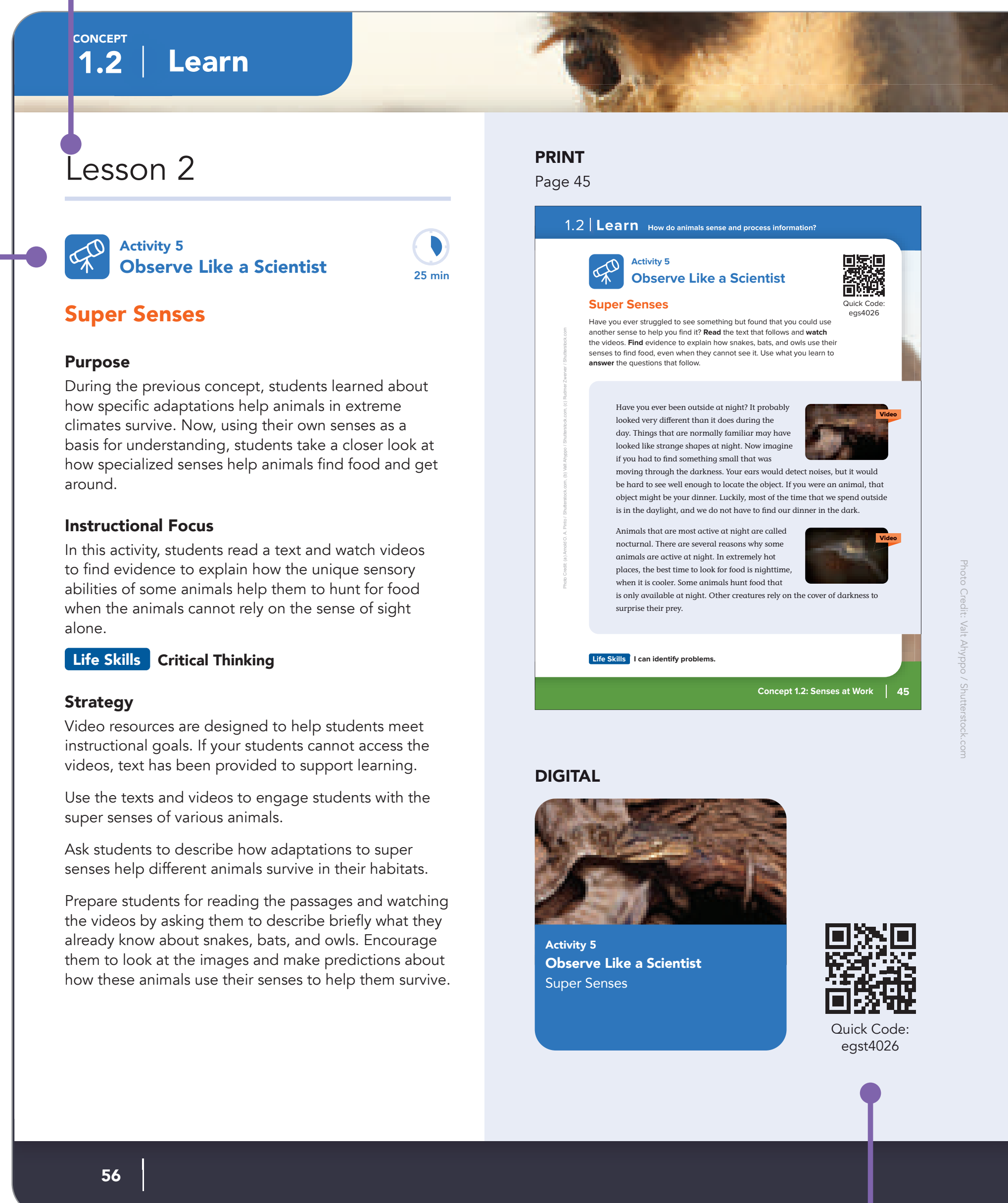
Concept Daily Instruction Features

Lessons

Instruction is presented in 45-minute segments by lesson.

Activities

Within each day, strategies for a variety of activity types guide teachers through possible means of classroom implementation.



CONCEPT **1.2** | **Learn**

Lesson 2

Activity 5
Observe Like a Scientist

25 min

Super Senses

Purpose

During the previous concept, students learned about how specific adaptations help animals in extreme climates survive. Now, using their own senses as a basis for understanding, students take a closer look at how specialized senses help animals find food and get around.

Instructional Focus

In this activity, students read a text and watch videos to find evidence to explain how the unique sensory abilities of some animals help them to hunt for food when the animals cannot rely on the sense of sight alone.

Life Skills Critical Thinking

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Use the texts and videos to engage students with the super senses of various animals.

Ask students to describe how adaptations to super senses help different animals survive in their habitats.

Prepare students for reading the passages and watching the videos by asking them to describe briefly what they already know about snakes, bats, and owls. Encourage them to look at the images and make predictions about how these animals use their senses to help them survive.

PRINT
Page 45

1.2 | **Learn** How do animals sense and process information?

Activity 5
Observe Like a Scientist

Quick Code: egs4026

Super Senses

Have you ever struggled to see something but found that you could use another sense to help you find it? **Read** the text that follows and **watch** the videos. **Find** evidence to explain how snakes, bats, and owls use their senses to find food, even when they cannot see it. Use what you learn to **answer** the questions that follow.

Have you ever been outside at night? It probably looked very different than it does during the day. Things that are normally familiar may have looked like strange shapes at night. Now imagine if you had to find something small that was moving through the darkness. Your ears would detect noises, but it would be hard to see well enough to locate the object. If you were an animal, that object might be your dinner. Luckily, most of the time that we spend outside is in the daylight, and we do not have to find our dinner in the dark.

Video

Animals that are most active at night are called nocturnal. There are several reasons why some animals are active at night. In extremely hot places, the best time to look for food is nighttime, when it is cooler. Some animals hunt food that is only available at night. Other creatures rely on the cover of darkness to surprise their prey.

Video

Photo Credit: (a) Arnold O. A. Pinto / Shutterstock.com, (b) Valt Ahyppo / Shutterstock.com, (c) Rudmer Zwerver / Shutterstock.com

Life Skills I can identify problems.

Concept 1.2: Senses at Work | 45

DIGITAL

Activity 5
Observe Like a Scientist
Super Senses

Quick Code:
egst4026

Photo Credit: Valt Ahyppo / Shutterstock.com

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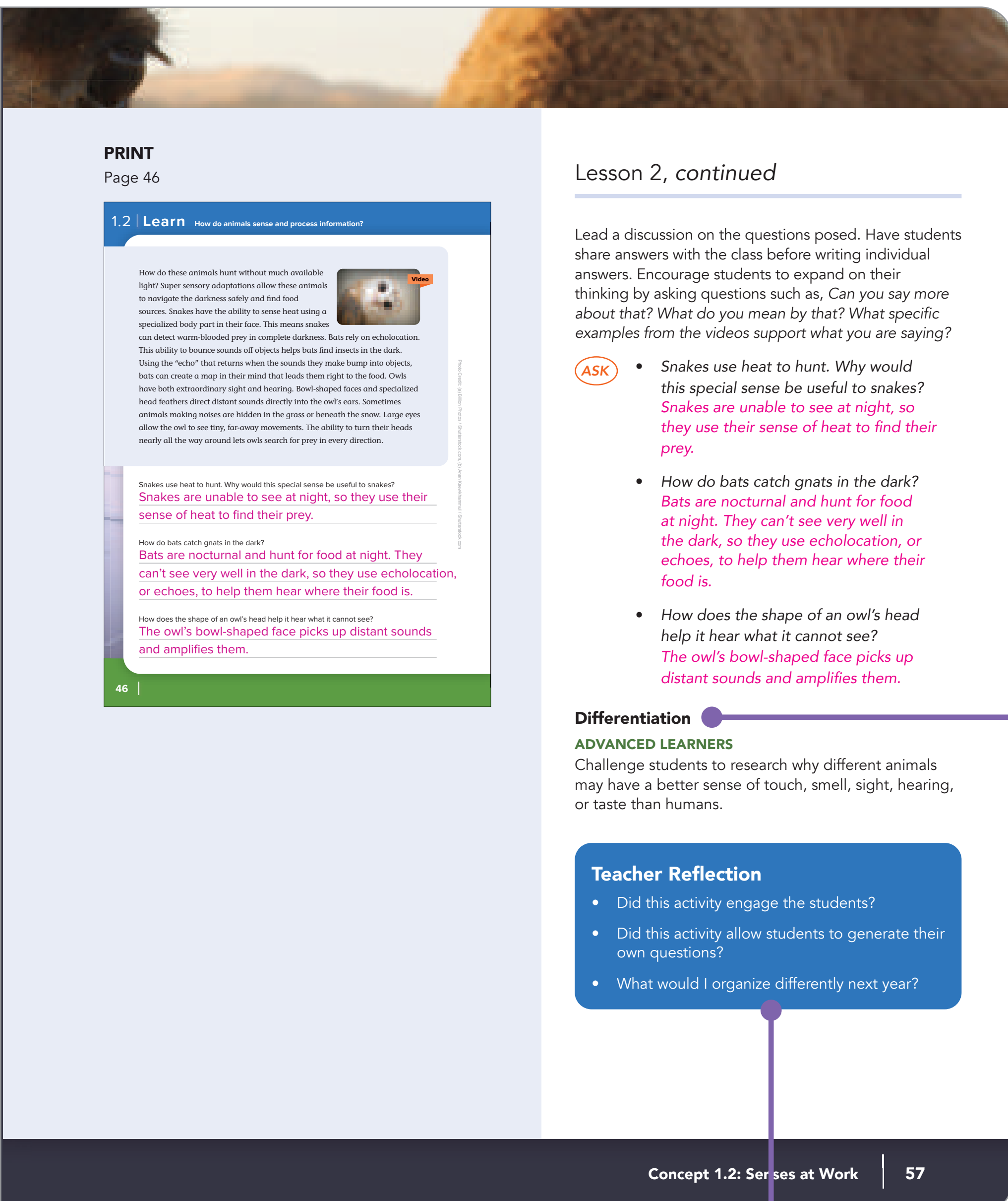
Quick Digital Access

Throughout the print Student and Teacher Editions, QR codes and short links indicate opportunities to go digital to deepen learning through rich media or assessment opportunities.



PRINT

Page 46

1.2 | **Learn** How do animals sense and process information?

How do these animals hunt without much available light? Super sensory adaptations allow these animals to navigate the darkness safely and find food sources. Snakes have the ability to sense heat using a specialized body part in their face. This means snakes can detect warm-blooded prey in complete darkness. Bats rely on echolocation. This ability to bounce sounds off objects helps bats find insects in the dark. Using the "echo" that returns when the sounds they make bump into objects, bats can create a map in their mind that leads them right to the food. Owls have both extraordinary sight and hearing. Bowl-shaped faces and specialized head feathers direct distant sounds directly into the owl's ears. Sometimes animals making noises are hidden in the grass or beneath the snow. Large eyes allow the owl to see tiny, far-away movements. The ability to turn their heads nearly all the way around lets owls search for prey in every direction.

Video

Snakes use heat to hunt. Why would this special sense be useful to snakes?
Snakes are unable to see at night, so they use their sense of heat to find their prey.

How do bats catch gnats in the dark?
Bats are nocturnal and hunt for food at night. They can't see very well in the dark, so they use echolocation, or echoes, to help them hear where their food is.

How does the shape of an owl's head help it hear what it cannot see?
The owl's bowl-shaped face picks up distant sounds and amplifies them.

Lesson 2, *continued*

Lead a discussion on the questions posed. Have students share answers with the class before writing individual answers. Encourage students to expand on their thinking by asking questions such as, *Can you say more about that? What do you mean by that? What specific examples from the videos support what you are saying?*

ASK

- *Snakes use heat to hunt. Why would this special sense be useful to snakes?*
  Snakes are unable to see at night, so they use their sense of heat to find their prey.
- *How do bats catch gnats in the dark?*
  Bats are nocturnal and hunt for food at night. They can't see very well in the dark, so they use echolocation, or echoes, to help them hear where their food is.
- *How does the shape of an owl's head help it hear what it cannot see?*
  The owl's bowl-shaped face picks up distant sounds and amplifies them.

Differentiation

ADVANCED LEARNERS

Challenge students to research why different animals may have a better sense of touch, smell, sight, hearing, or taste than humans.

Teacher Reflection

- Did this activity engage the students?
- Did this activity allow students to generate their own questions?
- What would I organize differently next year?

Differentiated Instruction

Primary 4 Science Techbook allows teachers to differentiate instruction, degrees of readiness, and interests. Techbook also offers resources to help vary content, process, product, and learning environment through the core instructional pathway. Point-of-use teacher notes are integrated to support approaching and advanced learners.

Built upon the principles of Universal Design for Learning, Primary 4 Science Techbook features a variety of content types, including images, video, audio, text, interactives, and Hands-On Investigations. These multimedia resources, included in both digital and print, provide multiple representations of the content and the flexibility for teachers to assign targeted content to whole groups or individual students.

Teacher Reflection

Throughout each concept, questions encourage teachers to consider how activities are working in their classrooms and how well students are accessing the material.

Interdisciplinary STEM Focus

Globally Prepared Students: A Focus on STEM, Career, Life Skills, and Entrepreneurship

Preparing students in Egypt to be globally competitive is a major focus of Education 2.0. Solving many of the challenges facing our world today and tomorrow will require integrating skills and knowledge from science, technology, engineering, and math, as well as core life skills. The Primary 4 Science Techbook introduces age-appropriate examples of these challenges that align to Egyptian Issues such as citizenship, globalization, and the environment and development. STEM applications are highlighted throughout this course in Share activities, STEM Project Starters, and Interdisciplinary Projects.

Share Activities

At the end of each concept, students synthesize learning in a series of Share activities. Students construct scientific explanations related to the opening Can You Explain? question (or other student-generated questions from Wonder). Students consider real-world applications by exploring career and entrepreneurship connections. And finally, students summarize learning by thinking about, writing about, and reviewing connections to the big ideas of the unit.

ENTREPRENEURSHIP
Entrepreneurs set goals by determining priorities and action plans. As you read about field biologists, think of ways their work might require the setting of short, medium, and long term goals. How might field biologists and researchers need to adapt to unexpected changes?

STEM Project Starters

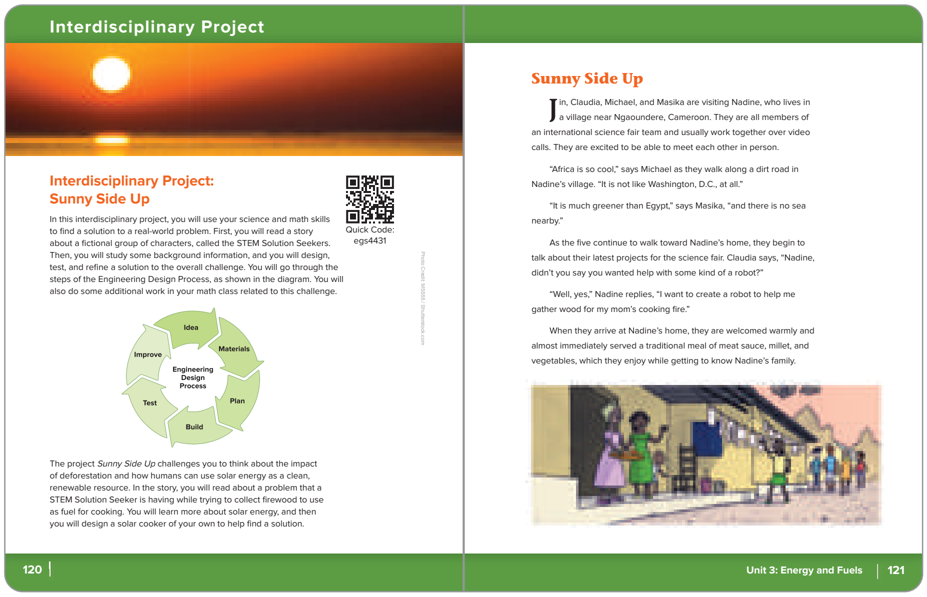
The Egypt Primary 4 Science curriculum builds on the multidisciplinary Discover from Primary 1 through Primary 3, using an integrated approach to life skills, career connections, and entrepreneurship through a STEM focus. Extensions found in the Share section of the digital Techbook, called STEM Project Starters, highlight the connections between students' work and current and future STEM careers. The focus on entrepreneurship, career skills, and real-world challenges allow students an opportunity to innovate and develop life skills of creativity, problem-solving, and self-expression.

The STEM Project Starters require students to connect math, technology, and engineering to their understanding of science concepts. STEM Project Starters focus on multiple aspects of STEM and challenge students to apply in new ways the content and learning from each concept.

Interdisciplinary Projects: Content and Real-World Connections

A unique addition to the Primary 4 Science Techbook is the Interdisciplinary Projects, provided for students once per term. These Interdisciplinary Projects are based on real-world challenges derived from the United Nations Sustainable Development Goals. Countries across the globe adopted these Sustainable Development Goals in 2015 (with annual monitoring and tracking) to "end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030.[1]"

For students to authentically connect academic content, practice life skills, and deeply understand the Egyptian Issues, we must provide opportunities for students to search for their own solutions. The Interdisciplinary Projects allow students to do just that. Students are presented with a challenge and then given the opportunity to generate ideas using knowledge and skills from science, mathematics, and other disciplines. Students work with classmates to design a solution to build, test, and refine using the Engineering Design Process.



The Interdisciplinary Project for this term, "Sunny Side Up," challenges students to consider sustainable fuel sources. Students investigate the availability of sunlight hours in the region, and explore ways solar energy can be captured and converted to heat energy in a solar cooker.

[1] https://www.undp.org/content/undp/en/home/sustainable-development-goals.html

The Writing Process and Science Connection

Writing is an important part of science because it is how real scientists document and communicate their ideas, activities, and findings to others. Primary 4 Science Techbook engages students in many kinds of writing, especially argumentation. Argumentative writing in science calls for the use of evidence, often requiring students to read across several texts, watch videos and other media, and integrate findings from Hands-On Investigations.

Informational texts throughout Techbook help students strengthen their reading comprehension skills and develop both academic and discipline-specific language, while multimedia resources provide context and assist students in accessing the text. Primary 4 Science Techbook also authentically incorporates the writing process and expects students to use speaking and listening skills to demonstrate their understanding of science.

During the Share portion of each concept, students are asked to integrate their ideas in writing. Using the claim-evidence-reasoning structure, students learn to use evidence as a natural part of writing like a scientist. The first unit builds student skill in connecting claims and evidence. By the second unit, students expand on this skill to include articulation of both the evidence and reasoning that back up a claim. Both the digital and the print resources will engage students in the practice of this type of writing.

Teacher Reflection: How are you developing your students into scientific readers?

Teacher Reflection

- Did this activity engage the students?
- Did this activity allow students to generate their own questions?
- Would I organize this differently next year?

Building Academic Language of All Students

Reading and writing success in science depends on the ability of students to understand not only the definition of vocabulary words, but also how the academic language connects ideas, adds details, or organizes the text. Academic language is supported and emphasized through strategies for learning vocabulary, frequent vocabulary use in various texts, and formative assessment items.

Notes:

Primary 4 Science Scope and Sequence

Primary 4 • THEME	1	2	3	4
SCIENCE				
A. Skills and Processes				
1. Demonstrate thinking and acting inherent in the practice of science.				
a. Identify scientific and non-scientific questions.	•	•	•	•
b. Plan and carry out simple investigations to collaboratively produce data that answers a question.	•	•	•	•
c. Represent data in tables and graphs, compare the styles of representation.	•	•	•	•
d. Construct an argument with evidence and data.	•	•	•	•
e. Develop and/or use models to explain natural phenomena.	•	•	•	•
f. Use multiple texts to answer questions or explain phenomena.	•	•	•	•
g. Communicate scientific information orally and in written formats.	•	•	•	•
B. Earth and Space Science				
1. Use scientific skills and processes to explain the chemical and physical interactions of the environment, Earth, and the universe that occur over time.				
a. Describe the effects of some weathering factors (such as water or wind erosion). 1) Identify evidence from patterns in rock formations to support an explanation for changes in a landscape over time (such as a river changing course over time or the effect of a wind barrier being removed).				•
b. Identify connections between Earth's geologic processes and three main types of rocks: 1) Igneous (formed from volcanic activity) 2) Sedimentary (formed via deposition) 3) Metamorphic (formed as the result of change)				•

	1	2	3	4
C. Life Science				
1. Use scientific skills to describe the essential needs of a living organism (plants and animals, including humans).				
a. Classify plants, animals, and other living organisms using physical and other observable characteristics of the organisms. 1) Explain the objectives and purpose of classifications. 2) Provide examples of living organisms with similar physical characteristics.	•			
b. Propose ways to maintain the health and safety of the digestive system. 1) Relate the organs involved in digestion to their function in the digestive system. 2) Explain how the organs in the digestive system work together to break down and absorb food for energy. 3) Identify potential sources of damage related to the digestive system.	•			
c. Advocate for how to maintain the health and safety of the air living organisms rely on for life (for example, design a public message or advertising campaign). 1) Relate the organs involved in breathing to their function in the respiratory system for multiple species (such as humans and fish). 2) Identify threats to healthy respiration (such as smoking or causes of air and water pollution).	•		•	
d. Analyze examples of how animals receive different types of information through their senses, process the information in their brains, and respond to the information in different ways. 1) Explain how structural adaptation relating to senses helps organisms survive in specific environments. 2) Use evidence to explain that multiple adaptations or organs work together in systems to help organisms gather information needed to survive in specific habitats. 3) Develop a model that shows how organisms respond to changes in their habitat over time.	•		•	

Primary 4 • THEME	1	2	3	4
D. Physical Science				
1. Use scientific skills and process to explain the interactions of matter and energy and the energy transformations that occur.				
a. Use evidence to construct an explanation relating the speed of an object to the energy of that object. 1) Explain the basic connection between energy and movement.		•		•
b. Ask questions and predict outcomes about the changes in energy that occur when objects collide.		•		•
c. Summarize observations of how energy can be transferred from place to place by sound, light, heat, and/or electric currents. 1) Identify various forms of energy. 2) Describe everyday examples of energy changing from one form to another. 3) Explain how some everyday devices transform energy. 4) Identify the energy transformations that occur when energy is used to run a device in the home or school.	•	•	•	
d. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. [Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and a passive solar heater that converts light into heat.]		•	•	

	1	2	3	4
E. Environmental Science				
1. Use scientific skills and process to explain the interactions of environmental factors (living and nonliving and analyze their impact on a local and global scale.				
a. Analyze how the use of fuels derived from natural resources affect the environment. *[Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]* 1) Identify and compare various renewable and nonrenewable sources of energy in the environment. 2) Diagram the role of fuel sources in producing electricity. 3) Describe how the use of energy and fuels affects the environment. 4) Propose local or national solutions for reducing the impact of energy and fuel use (such as decreasing local energy consumption or increasing nationwide use of alternative energy sources).			•	
F. Engineering Design and Process				
1. Apply engineering design processes and understanding of the nature and characteristics of technology to solve problems.				
a. With support, explain the characteristics and scope of technology.		•		
b. With support, explain the role of society in the development and use of technology.		•		
c. Define a simple design problem that can be solved through the development of an object, tool, process, or system.	•			•
d. Apply the design process with support, using tools and materials to plan and/or build a device that solves a specific problem.		•		•
e. Analyze data from tests of an object or tool to determine whether it works as intended.		•		
f. Assess the impact of products and systems with support.	•			•

UNIT 3

Energy and Fuels

Photo Credit: Maksim Safaniuk / Shutterstock.com

Theme 3 | Protecting Our Planet

Unit 3
Energy and Fuels

Learning Indicators

Throughout this unit, students will work toward the following learning indicators:

Primary 4 • CONCEPT	3.1	3.2	3.3
SCIENCE			
A. Skills and Processes			
1. Demonstrate thinking and acting inherent in the practice of science.			
a. Identify scientific and nonscientific questions.	•	•	•
b. Plan and carry out simple investigations to collaboratively produce data that answers a question.	•	•	•
c. Represent data in tables and graphs and compare the styles of representation.	•		•
d. Construct an argument with evidence and data.	•	•	•
e. Develop and/or use models to explain natural phenomena.	•		•
f. Use multiple texts to answer questions or explain phenomena.	•	•	•
g. Communicate scientific information orally and in written format.	•	•	•
C. Life Science			
1. Use scientific skills to describe the essential needs of a living organism (plants and animals, including humans).			
c. Advocate for how to maintain the health and safety of the air living organisms rely on for life (for example, design a public message or advertising campaign). 1) Identify threats to healthy respiration (such as smoking or causes of air and water pollution).		•	

	3.1	3.2	3.3
D. Physical Science			
1. Use scientific skills and processes to explain the interactions of matter and energy and the energy transformations that occur.			
c. Summarize observations of how energy can be transferred from place to place by sound, light, heat, and/or electric currents. 1) Identify various forms of energy. 2) Describe everyday examples of energy changing from one form to another. 3) Explain how some everyday devices transform energy. 4) Identify the energy transformations that occur when energy is used to run a device in the home or school.	•	•	•
d. Apply scientific ideas to design, test, or refine a device that converts energy from one form to another. *[Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound and a passive solar heater that converts light into heat.]*	•		•
E. Environmental Science			
1. Use scientific skills and processes to explain the interactions of environmental factors (living and nonliving) and analyze their impact on a local and global scale.			
a. Analyze how the use of fuels derived from natural resources affects the environment. *[Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.]* 1) Identify and compare various renewable and nonrenewable sources of energy in the environment. 2) Diagram the role of fuel sources in producing electricity. 3) Describe how the use of energy and fuels affects the environment. 4) Propose local or national solutions for reducing the impact of energy and fuel use (such as decreasing local energy consumption or increasing nationwide use of alternative energy sources).		•	•

Unit Outline

Anchor Phenomenon: Get Started

Water for Energy
Students will learn to see water as a renewable resource that possesses kinetic energy, which allows for the production of electricity to power devices. Students should begin to understand that the production of energy for transportation, our homes, and industry has an impact on our environment.

Unit Project Preview

Dam Impacts
Students will assess the positive and negative impacts of a dam on the surrounding environment and community, including humans, wildlife, and the landscape. Students will return to the project at the end of the unit.

Concepts

3.1 Devices and Energy
Students will learn to identify some forms of energy and how energy is transferred and conserved.

3.2 About Fuels
Students will learn to classify fuels as renewable or nonrenewable.

3.3 Renewable Energy Resources
Students will identify common renewable resources and describe how renewable energy sources can be used to meet certain energy needs.

Unit Project

Dam Impacts
This summative assessment provides students with the opportunity to analyze the upstream and downstream effects of building a dam.

Unit Storyline

This unit opens with familiar images of fuels being used to cook food, provide warmth and light, and power devices. Students are asked to think of where the energy or fuel originated and how this energy is captured and used. One example of a natural resource being captured to generate energy is water. Students are asked to consider how people for centuries have harnessed the kinetic energy of flowing, falling, and rushing water, by first using watermills and now through hydroelectric dams. They observe that energy can be transferred from place to place in the form of sound, light, heat, and electricity. Building on this, students obtain information to describe how energy used to move cars can be derived from fuels extracted from natural resources. In some cases, fuels are burned to extract their energy, while in other cases, renewable energy resources can be harnessed, as in the case of wind turbines. Students use what they have learned about nonrenewable and renewable energy resources to evaluate the impact that energy use has on the environment, including pollution from burning fossil fuels. Finally, to summarize their learning, students return to harnessing the power of water and consider the damming of a river. They research the benefits and drawbacks of a dam and propose solutions to address the environmental harm human use of energy causes.

Unit 3 Introduction: Get Started

What I Already Know

Quick Code: egst4250

The third unit in Primary 4 Science is focused on energy and fuels. Begin the unit by asking students to share what they may already know about fuels that humans use for energy. Students will probably share examples related to transportation (gasoline for cars and so on); cooking; or to provide warmth, heat, or light. Encourage students to think of the variety of ways we depend on energy in the form of electrical power as well. Students are asked to first examine two images that show energy being used for cooking. Ask students to think of other ways to cook food—perhaps they have seen a solar cooker? Then, direct students to look at the third image and think about how the woman shown is using energy. Students will likely note the fire burning in the background, but also encourage them to think about her computer, the lights in the room, and so on.

Shift the class discussion from the hopefully familiar images in the What I Already Know activity to watch the video, study the image, and read the provided text for the Anchor Phenomenon Water for Energy. Video resources are designed to help students meet instructional goals. If your students cannot access the video, text has been provided to support learning.


Get Started

What I Already Know

Quick Code: egs4250

This unit is all about energy and fuels. **Think** about how humans use fuel for energy. **Look** at the first two images on this page. What types of fuels are shown? How is the energy from the fuel being used? Then, **look** at the third image. You can see the fire, but are there other examples of energy from fuel that you can see in the photo? **Write** some ideas you have about how humans use fuel and how we use energy that comes from fuel.

Answers will vary. We use fuels to cook food, power devices, get warm, and provide light. We can use wood or gas for fuel. We also use electricity, which is a form of energy that originally comes from a fuel.

Talk Together Think about the items in your house that require energy or fuel. Where do you think that energy or fuel comes from? Share your ideas with a partner.

Now that you have learned about energy as it relates to work and motion, this unit will help you look at energy in a different way. During this unit, you will learn a lot more about how energy helps humans do everything from cook food to drive cars to power everyday devices. You will explore where this kind of energy comes from. You will explore different types of fuels and learn the difference between renewable and nonrenewable resources. You will investigate certain kinds of renewable energy that come from the sun, wind, or water. Finally, you will consider the impact on the environment when we use different kinds of resources for energy, whether they are renewable or nonrenewable.

Photo Credit: (a) Maksim Safaniuk / Shutterstock.com, (b) Mohamed Elkhamisy / Shutterstock.com, (c) goodbishop / Shutterstock.com, (d) Wirestock Creators / Shutterstock.com, (e) Icon made by Freepik from www.flaticon.com

Unit 3: Energy and Fuels | 1

Anchor Phenomenon: Water for Energy

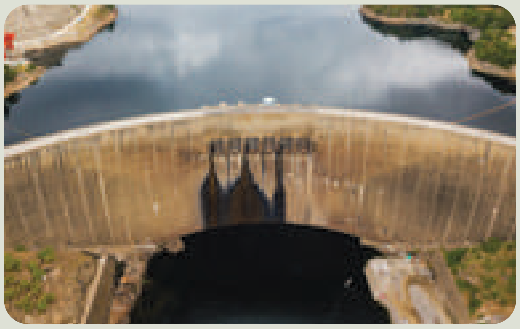
The focus of this unit, energy and fuels, starts with presenting one resource used for energy—water. The Anchor Phenomenon and the Unit Project help students make the connection between the generation of energy in the form of electricity and the movement or kinetic energy of rushing or falling water. Review the Guiding Questions, provided on the next page, with students and encourage students to share experiences and prior knowledge about other sources of energy or fuels.

Guiding Questions

- How do we use natural resources such as water as an energy resource?
- Where does energy, in the form of electricity and fuel, come from?
- How is electricity used to power electronic devices?
- Why do humans use natural resources?
- How quickly are we using natural resources?

Unit Project Preview

Dam Impacts



Quick Code: egst4251

Introduce the idea of a unit project to students. Students should be familiar with project-based assessments from previous study in lower grades. The unit project asks students to consider the impacts of a dam being used to generate hydroelectric power. Students may not be familiar with the specific dam mentioned, the Kariba Dam. However, students may be familiar with local examples of dams or hydroelectric power plants. Encourage students to talk about other examples of using water to generate power or energy. Discuss the questions with the class and ask students to respond. Encourage students to think of additional questions they have about how a natural resource, like water, can be used to generate energy that humans can harness or use. You may wish to post these questions in the classroom as an ongoing reminder throughout the unit.

Questions

- What do you notice about this image of the Kariba Dam in Southern Africa?
- How do you think dams can change the landscape?
- How do you think changing the landscape can affect plants, animals, and humans?

CONCEPT

3.1

Devices and Energy

Photo Credit: Smile Fight / Shutterstock.com

Photo Credit: Smile Fight / Shutterstock.com

Concept Objectives

By the end of this concept, students should be able to:

- Develop models based on observations that describe how everyday devices transform energy.
- Use observations and evidence to explain how energy is transferred from place to place.

Quick Code:
egst4252

Key Vocabulary

new: chemical energy, Earth, energy conservation, energy source, energy transfer, sound, sun

review: kinetic energy

Quick Code:
egst4253

Key Vocabulary Strategies

Vocab Detective

- As students are being introduced to the vocabulary words, give each student a piece of paper or a small pad of sticky notes. Each time the student runs across a vocabulary word in the day's reading, have them write the entire sentence that contains the vocabulary word and place it on their desk. Students can also write any surrounding context that may help with the definition.
- At the end of each day, take a few minutes for students to share some of the sentences they found. Ask the students to define the vocabulary word in the context of that sentence.

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Get Started		Get Started	15 min
Wonder	Lesson 1	Activity 1	10 min
		Activity 2	10 min
		Activity 3	10 min
		Activity 4	10 min
Learn	Lesson 2	Activity 5	10 min
		Activity 6	25 min
	Lesson 3	Activity 6, *continued*	25 min
		Activity 7	20 min
	Lesson 4	Activity 8	10 min
		Activity 9	20 min
Share		Activity 10	15 min

Content Background

In this concept, students learn about the transfer and transformation of energy through devices. Students also learn to model the input and output of energy. By taking a close look at these processes in devices that are familiar to students, such as cell phones, student are able to connect theoretical learning to experiences that are a part of their everyday lives.

Energy in Machines

Modern human society depends on mechanical systems that use energy. No matter how complex the devices we use become, nearly all the energy that powers them can be traced back to the sun. Most devices rely on electricity as a power source. To generate electricity, we can convert the sun's energy in a number of ways. The most common method involves the burning of fossil fuels (coal, oil, and natural gas). As we burn this stored energy, it is transformed into the mechanical energy, electricity, or thermal energy we use to power our devices and our planet.

Energy Conversions

In the same way that energy travels through natural systems, energy changes forms as it travels through mechanical systems. A car is an example of a mechanical system that students have practical knowledge of. Electricity comes from the conversion of a primary source of energy, such as the sun, fossil fuels, or nuclear energy. Stored electrical energy typically refers to batteries, such as a car battery. Batteries use chemicals to produce electrons that can be transferred to other objects, thus providing them with energy. Fuel, which was created via the sun, is converted into mechanical energy that gives a car the ability to move. Along with the mechanical energy, cars also release thermal energy. Thermal energy is often referred to as lost energy.

The term *lost energy* leads to some common misunderstanding for students. In actuality, energy is never lost or gained. However, in the process of energy conversions from input to output, energy is often transformed into types that are different than the intended use of the device. For example, an electric mixer converts electrical energy into mechanical energy as the beaters spin. While you use the device, you can hear the whir of the beaters—sound energy. After using the device, if you hold your hand on the outside of the motor, you can feel the heat that has been generated. Since this heat and sound are not part of the intended use of the device, we call this lost energy. Some systems can change upward of 90 percent of their energy into thermal energy.

Hands-On Investigations Preparation

Learn

Location	Instructional Focus	Materials to Prepare (per group)
Activity 6: Energy and Everyday Devices	In this activity, students analyze common devices to determine the energy input and output of each device.	• Collect materials from around the classroom that students can use to identify energy input and output. Invite students to bring objects from home to share with the class. • Possible items could include: a handheld fan; a small, battery-powered clock; a flashlight; pull-back toy cars; a handbell; and so on.
Activity 9: Build an Energy Chain	In this activity, students model energy transfer pathways by creating an energy chain.	• Magazine • Scissors • Masking tape • Sketch paper • Poster board • Colored pencils

Lesson 1

Activity 1
Can You Explain?

10 min

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Purpose

This activity draws on students' prior knowledge and personal experiences by asking them to think about how we use solar energy to power common devices.

Instructional Focus

In this activity, students use prior knowledge to construct an explanation of the energy transfers that occur as energy moves from place to place.

Life Skills **Endurance**

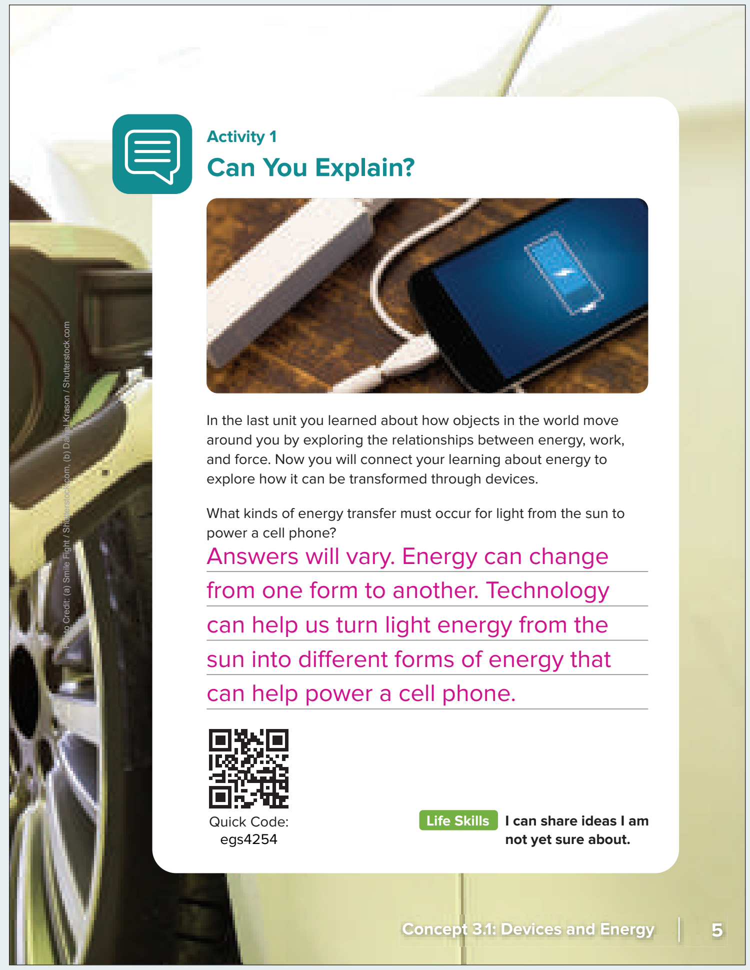
Strategy

Encourage students to explain what they know about energy transfer in human-made devices. Challenge students to think about how energy is used when objects move.

Students may have some initial ideas about how to answer the question. (See sample student response in the Student Materials.) By the end of the concept, students should be able to construct a scientific explanation that includes evidence from the concept activities.

PRINT

Page 5



Activity 1
Can You Explain?

In the last unit you learned about how objects in the world move around you by exploring the relationships between energy, work, and force. Now you will connect your learning about energy to explore how it can be transformed through devices.

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Answers will vary. Energy can change from one form to another. Technology can help us turn light energy from the sun into different forms of energy that can help power a cell phone.

Quick Code: egs4254

Life Skills I can share ideas I am not yet sure about.

Concept 3.1: Devices and Energy | 5

DIGITAL

Activity 1
Can You Explain?

Quick Code: egst4254

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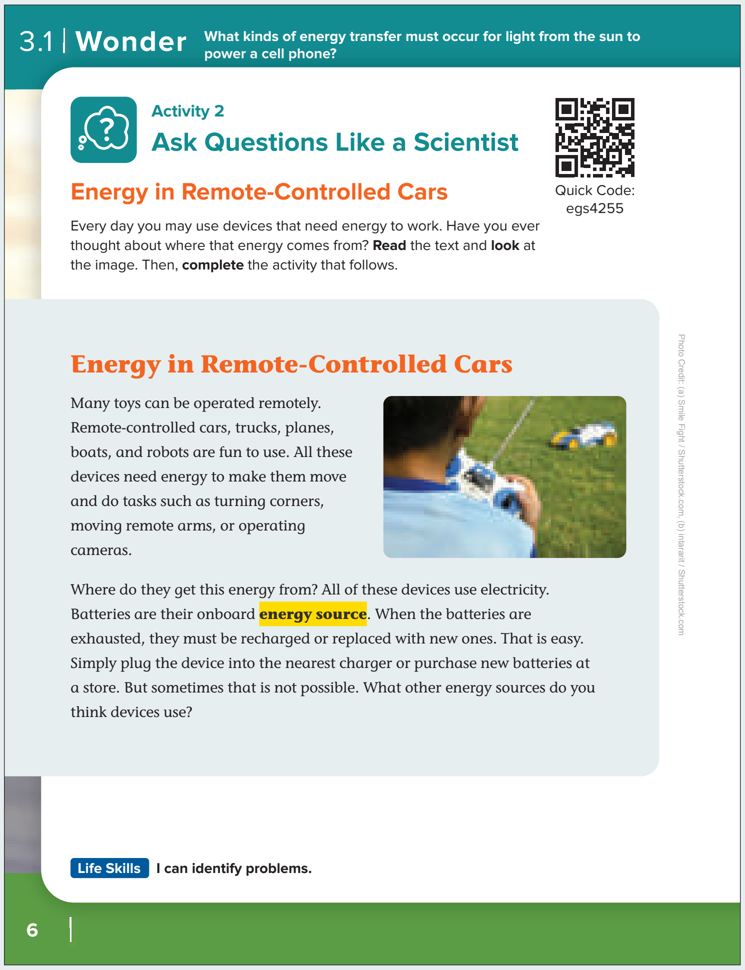
Page 6



3.1 | **Wonder** What kinds of energy transfer must occur for light from the sun to power a cell phone?

Activity 2

Ask Questions Like a Scientist

Quick Code: egs4255

Energy in Remote-Controlled Cars

Every day you may use devices that need energy to work. Have you ever thought about where that energy comes from? **Read** the text and **look** at the image. Then, **complete** the activity that follows.

Energy in Remote-Controlled Cars

Many toys can be operated remotely. Remote-controlled cars, trucks, planes, boats, and robots are fun to use. All these devices need energy to make them move and do tasks such as turning corners, moving remote arms, or operating cameras.

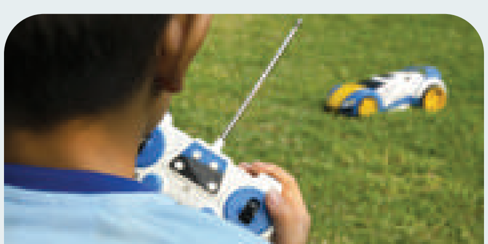
Where do they get this energy from? All of these devices use electricity. Batteries are their onboard **energy source**. When the batteries are exhausted, they must be recharged or replaced with new ones. That is easy. Simply plug the device into the nearest charger or purchase new batteries at a store. But sometimes that is not possible. What other energy sources do you think devices use?

Life Skills I can identify problems.

6

Photo Credit: intararit / Shutterstock.com

DIGITAL



Activity 2

Ask Questions Like a Scientist

Energy in Remote-Controlled Cars

Quick Code: egst4255

Investigative Phenomenon

Activity 2

Ask Questions Like a Scientist

10 min

Energy in Remote-Controlled Cars

Purpose

The Investigative Phenomenon sparks curiosity in students as they begin to consider how the devices that they use every day get the energy they need to operate. Although many students may be familiar with batteries, they may not have a complete understanding of how energy is stored in batteries.

Instructional Focus

In this activity, students share their prior knowledge of real-world examples of energy transfer in human-made devices.

Life Skills **Critical Thinking**

Strategy

To introduce the idea that energy must come from somewhere, use the example of battery-powered toys, such as remote-controlled cars. Ask a student to bring one to class, or ask students to share experiences using one, describing how it works. Use this and the text to stimulate student thinking about where the energy for the car comes from and where it goes.

Lesson 1, *continued*

Students will identify batteries as the source, but challenge them with questions such as:

ASK

- *Where did the energy inside the batteries come from?*
  Student answers will vary. Energy flows from one side of the battery to the other side of the battery. When the battery is charged, energy is added to the battery.
- *What sort of energy was it?*
  Student answers will vary. Batteries use chemical energy.
- *Where did it go after it was used by the car?*
  Student answers will vary. The energy is transferred to kinetic (motion) energy, sound, and heat energy.

Students should tap into their knowledge about types of energy sources to answer these questions. If students are familiar with solar panels, use a known example to prompt student thinking about other sources of energy that could be used.

Ask students to think of, write down, and share questions they would like to investigate about the devices they use in their daily lives and the energy that these devices use.

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Page 7

Think about the devices you use in your daily lives and the energy they use.
Write three questions you have in the chart below.

I wonder . . .
Student responses will vary.

I wonder . . .
How do solar-powered devices such as calculators work?

I wonder . . .
How does the electricity from a charger recharge a battery?

Photo Credit: Smile Fight / Shutterstock.com

Concept 3.1: Devices and Energy | 7

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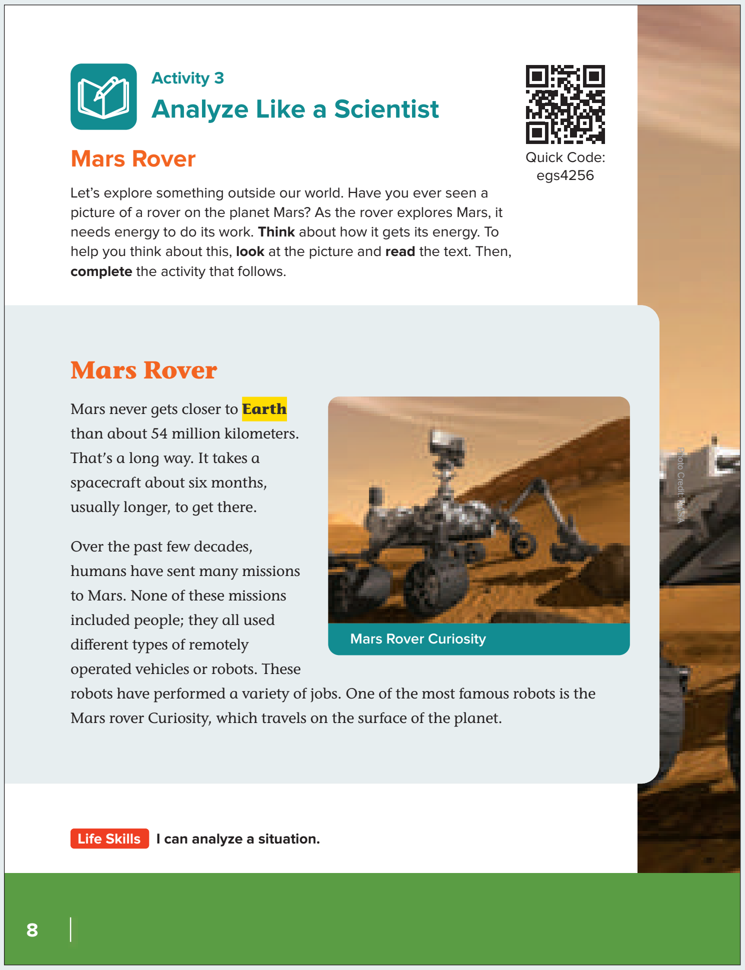
Page 8



Activity 3

Analyze Like a Scientist

Mars Rover

Quick Code: egs4256

Let's explore something outside our world. Have you ever seen a picture of a rover on the planet Mars? As the rover explores Mars, it needs energy to do its work. **Think** about how it gets its energy. To help you think about this, **look** at the picture and **read** the text. Then, **complete** the activity that follows.

Mars Rover

Mars never gets closer to **Earth** than about 54 million kilometers. That's a long way. It takes a spacecraft about six months, usually longer, to get there.

Over the past few decades, humans have sent many missions to Mars. None of these missions included people; they all used different types of remotely operated vehicles or robots. These robots have performed a variety of jobs. One of the most famous robots is the Mars rover Curiosity, which travels on the surface of the planet.

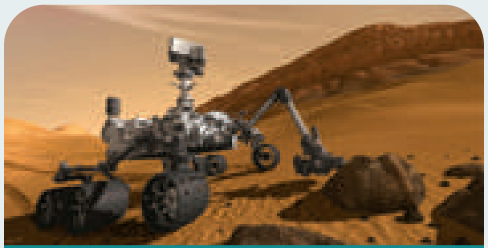
Mars Rover Curiosity

Life Skills I can analyze a situation.

8

Photo Credit: NASA

DIGITAL



Activity 3

Analyze Like a Scientist

Mars Rover

Quick Code:
egst4256

Activity 3

Analyze Like a Scientist

10 min

Mars Rover

Purpose

In this activity, students consider how a remotely operated vehicle might get its energy on Mars. This activity will encourage students to think about energy sources before beginning the Learn activities.

Instructional Focus

In this activity, students use an image of rover and a text section about the Mars rovers as evidence to predict how a rover might get its energy.

Life Skills **Decision-Making**

Strategy

Engage students' thinking by allowing students to share ideas and questions about the image and the text. Fully formed ideas are not necessary during the discussion or in the recording of ideas.

Show students the image Mars Rover Curiosity.

Ask students to share with a partner their ideas of what the rover might do on Mars and how it gets its energy.

Lesson 1, *continued*

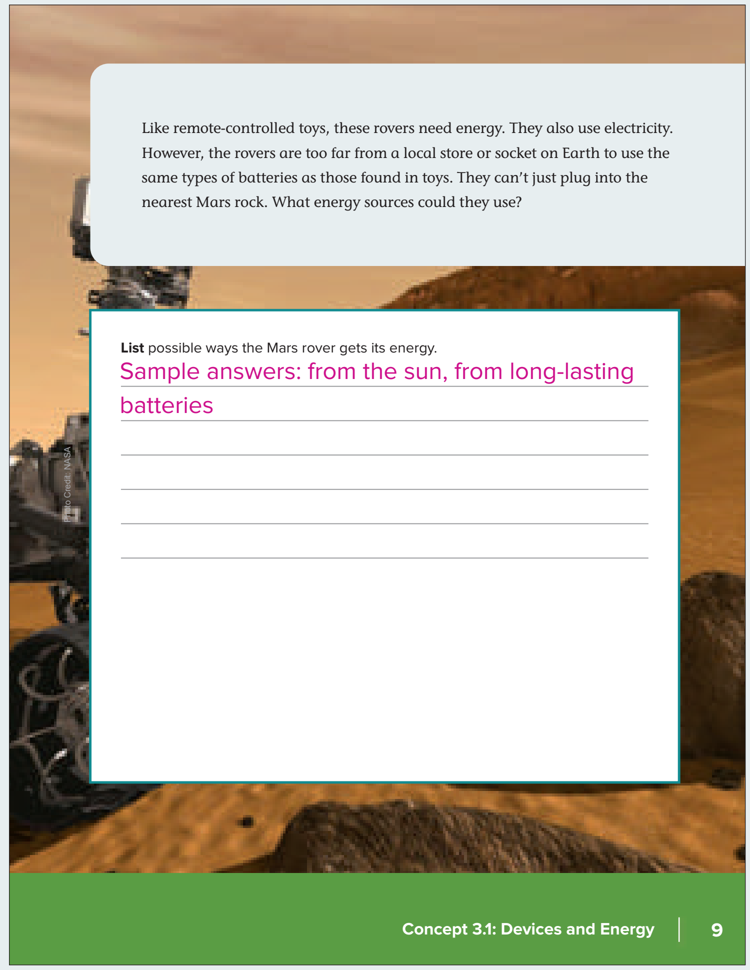
Provide the text section on the Mars rover to students. Ask students to share ideas about possible ways the rover gets its energy.

ASK

- *How does the Mars rover get energy to explore the surface of Mars?*
  Student answers will vary. The Mars rover uses batteries and solar panels for an energy source.
- *What are some ways the Mars rover uses energy as it explores the surface of Mars?*
  Student answers will vary. Because the Mars rover moves, it transforms energy in to kinetic (motion) energy, heat, and electric energy to run its sensors.

PRINT

Page 9


Like remote-controlled toys, these rovers need energy. They also use electricity. However, the rovers are too far from a local store or socket on Earth to use the same types of batteries as those found in toys. They can't just plug into the nearest Mars rock. What energy sources could they use?

List possible ways the Mars rover gets its energy.

Sample answers: from the sun, from long-lasting batteries

Concept 3.1: Devices and Energy | 9

PRINT

Page 10


3.1 | Wonder What kinds of energy transfer must occur for light from the sun to power a cell phone?

Activity 4

Evaluate Like a Scientist

Quick Code: egs4259

What Do You Already Know About Devices and Energy?

You have been thinking about how different devices get the energy they need to function. Now let's think about these devices when they are in use. How does the energy change? **Look** at the pictures. Then, **discuss** the questions with a partner.

Talk Together What is the source of energy, or energy input, for each device? What is the energy output?

Life Skills I can analyze a situation.

10

DIGITAL

Activity 4
Evaluate Like a Scientist
What Do You Already Know About Devices and Energy?

Quick Code: egst4259

Lesson 2

Activity 4

Evaluate Like a Scientist

10 min

What Do You Already Know About Devices and Energy?

Purpose

In preparation for learning about energy transfer, students reflect on what they already know about how devices get and give off energy. This formative assessment of prior knowledge will set the stage for upcoming lessons.

Instructional Focus

In this activity, students use prior knowledge to describe energy input and output. Students discuss how everyday devices get energy and how that energy changes when the device is in use.

Life Skills **Decision-Making**

Strategy

Show students the image of the hair dryer.

Ask students to discuss with a partner the answer to the question.

ASK *Where does the hair dryer get its energy?* *Students should indicate electricity as the energy source.*

Introduce the term *input*. Elicit answers to the question from students; encourage them to use the term *input* in their responses.

Introduce the term *output*. Ask students to discuss with a partner the answer to the question.

Lesson 2, *continued*

ASK *What type of energy is the electricity being converted into?*
Students may indicate thermal energy due to the heat output of the hair dryer.

Elicit answers, reminding students to use the term *output* in their responses. Then, repeat this process with the images of the soap dispenser and washing machine.

This exercise will allow students to begin thinking about devices as systems with inputs and outputs.

Differentiation

APPROACHING LEARNERS
Introduce the idea that energy can be transformed from one form to another by instructing students to rub their hands together briskly. Ask them to describe what kind of energy transformation is taking place as their hands warm up. Make sure they understand that the energy of motion is being converted into heat energy.

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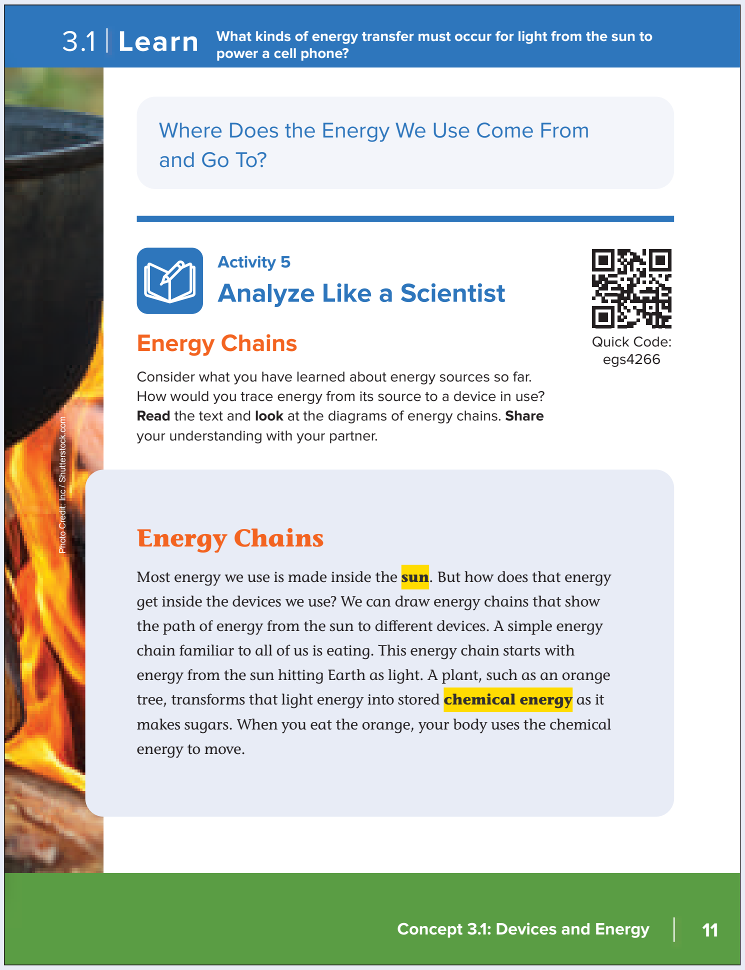
Pages 11–13



3.1 | Learn What kinds of energy transfer must occur for light from the sun to power a cell phone?

Where Does the Energy We Use Come From and Go To?

Activity 5
Analyze Like a Scientist

Quick Code: egs4266

Energy Chains

Consider what you have learned about energy sources so far. How would you trace energy from its source to a device in use? **Read** the text and **look** at the diagrams of energy chains. **Share** your understanding with your partner.

Energy Chains

Most energy we use is made inside the **sun**. But how does that energy get inside the devices we use? We can draw energy chains that show the path of energy from the sun to different devices. A simple energy chain familiar to all of us is eating. This energy chain starts with energy from the sun hitting Earth as light. A plant, such as an orange tree, transforms that light energy into stored **chemical energy** as it makes sugars. When you eat the orange, your body uses the chemical energy to move.

Photo Credit: Inc / Shutterstock.com

Concept 3.1: Devices and Energy | 11

Photo Credit: Inc / Shutterstock.com

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Activity 5
Analyze Like a Scientist
Energy Chains

Quick Code:
egst4266

Lesson 2, *continued*

Where Does the Energy We Use Come From and Go To?

Activity 5
Analyze Like a Scientist

10 min

Energy Chains

Purpose

This activity introduces an energy chain as one way to describe or diagram the transfer of energy that occurs when everyday devices are in use. Diagrams provide a visual representation to support student comprehension of the passage.

Instructional Focus

In this activity, students work collaboratively to read and explain models describing the transfer of energy within an energy chain.

Strategy

Tell students they will be reading about where energy comes from and where it goes in the text Energy Chains. They will take turns telling a partner what they read, in their own words. Explain the strategy using the following steps:

- First, students silently read the first paragraph and look at the first image. Then, the student whose birthday is the closer of the pair goes first to retell the paragraph.
- Continue by reading the next paragraph, but this time the other partner retells the text in their own words.
- Continue switching partners for each paragraph until the reading passage is completed.

Lesson 2, *continued*

Activity 6
Think Like a Scientist

25 min

Energy and Everyday Devices

Purpose

Students build on the previous introduction to energy chains through a hands-on investigation. Students collect observational data to apply what they learned about energy input and output to common devices.

Instructional Focus

In this activity, students analyze common items to determine the energy input and output of each device.

Life Skills **Problem-Solving**

Activity Activator

Arrange students in temporary groups in which at least one student has brought an item from home to share. Ask students to share the devices and, as a group, determine if the item uses energy to function. Once students have determined that the item uses energy, emphasize that all devices have both energy inputs and outputs. Discuss one or two of the examples. Ask students to share ideas about which types of energy go into and come out of these devices. For example, an electric space heater functions by converting electricity (input) into heat (thermal energy, output).

To help prepare students for success, review the forms of energy already discussed in earlier concepts: mechanical, chemical, thermal (heat), radiant (light), electrical, and sound. As a group, create a simple chart for reference. Ask students to help list the types of energy and then list one or two examples of each.

Activity Procedure: What Will You Do?

Prepare different stations around the classroom, each with a different device for students to examine. If any of the devices need to be plugged in, put them at stations with electrical outlets. Number each station to facilitate movement from station to station. Arrange

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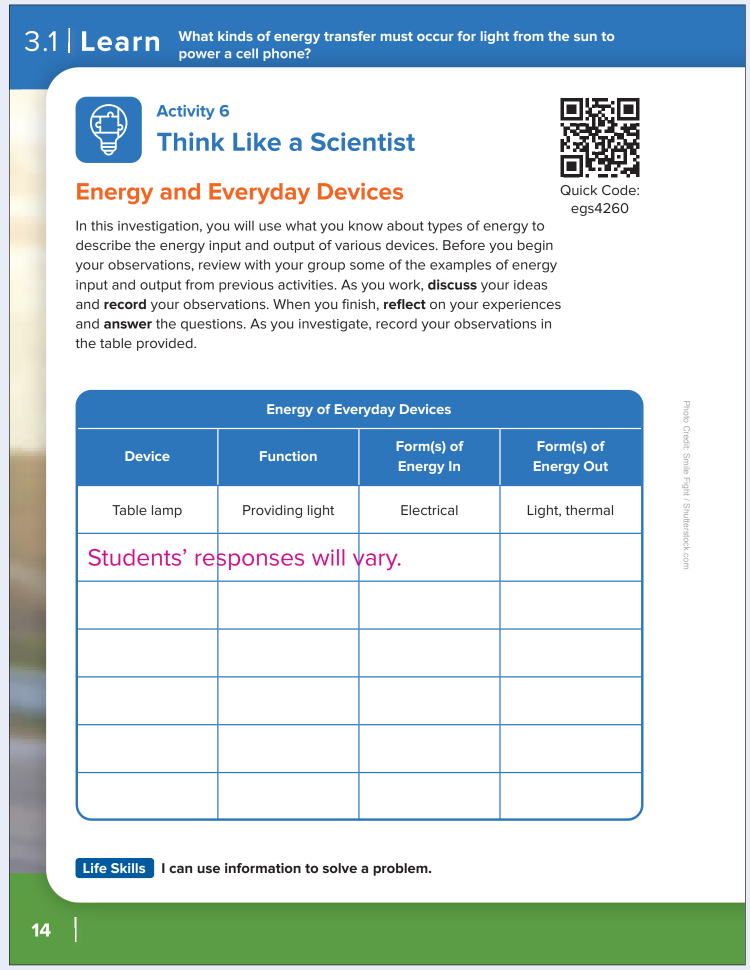
3.1 | Learn What kinds of energy transfer must occur for light from the sun to power a cell phone?

Activity 6
Think Like a Scientist

Quick Code: egs4260

Energy and Everyday Devices

In this investigation, you will use what you know about types of energy to describe the energy input and output of various devices. Before you begin your observations, review with your group some of the examples of energy input and output from previous activities. As you work, **discuss** your ideas and **record** your observations. When you finish, **reflect** on your experiences and **answer** the questions. As you investigate, record your observations in the table provided.

Energy of Everyday Devices

Device	Function	Form(s) of Energy In	Form(s) of Energy Out
Table lamp	Providing light	Electrical	Light, thermal
Students' responses will vary.			

Life Skills I can use information to solve a problem.

Photo Credit: Smile Fight / Shutterstock.com

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DIGITAL

Activity 6
Think Like a Scientist
Energy and Everyday Devices

Quick Code: egst4260

Photo Credit: Vasilyev Alexandr / Shutterstock.com

Materials List (per group)

Collect materials from around the classroom that students can use to identify energy input and output. Invite students to bring objects from home to share with the class.

Possible items could include:

- Handheld fan
- Small, battery-powered clock
- Flashlight
- Pull-back toy car or truck
- Handbell
- Table lamp

Preparation

Before class begins, determine the number and locations of the stations.

Safety

- Follow all lab safety guidelines, especially those associated with electricity.
- Be careful using sharp objects and tools.

Lesson 2, *continued*

the stations with enough space for students to examine each device without disturbing others. Arrange students in groups according to the number of objects available. Clearly indicate the direction in which students should move from station to station (for example, clockwise, counterclockwise, following arrows, and so on.). Consider providing basic tools, such as screwdrivers, if devices have battery compartments that cannot be opened without them. Be sure to discuss safety procedures with students before letting them examine electrical devices and tools. Do not let students completely disassemble devices since some electrical components carry a risk of shock even if not plugged in.

1. Organize students to work with a partner or small group so that the number of groups or pairs is equal to the number of stations you have set up around the room. Assign each pair or group to one of the stations around the room.
2. When you announce "Start," students begin to examine the device at their station.
3. Students work with their partner(s) to determine the function of each device, its energy input, and its energy output.
4. Students collect observational data by describing the device, its function, its energy input, and its energy output. Students record the station number in their charts to ensure that their data are correctly recorded.
5. After 5 minutes, announce "Switch," indicating that students should rotate to the next station. (Allow more time if needed.)
6. Have students repeat steps 2–5 of the procedure until they have visited each station.

Depending on the amount of time available and the number of stations or devices, this activity may need to be finished in a subsequent lesson. Leave stations in place until the next lesson if possible, or store all materials and clearly label each device with station numbers in order to set up again for the next lesson.

Lesson 3

Analysis and Conclusions: Think About the Activity

25 min

ASK

- *How did you determine the form(s) of energy that went into the use of each device?*
  Students should analyze their process and indicate how their conclusions related to tests they performed and observations they made.
- *How did you determine the form(s) of energy that came out of each device as it was used?*
  Students should analyze their process and indicate how their conclusions related to tests they performed and observations they made.
- *Does all of the energy that goes into each device come out as part of its function, or is some of the energy wasted? Support your answer with examples.*
  Students should conclude that some energy input is wasted in other forms. For example, some of the kinetic energy used to make a crank pencil sharpener function comes out as heat from friction.

MISCONCEPTION

Students may think that when energy changes take place, some of the energy is lost. In fact, energy is neither created nor destroyed. Sometimes, however, energy can be wasted when it changes forms because of friction or resistance.

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What Will You Do?

1. Analyze each device.
2. Determine the energy input for the device.
3. Determine the energy output for the device.
4. Record your observations in the Energy of Everyday Devices table.

Think About the Activity

How did you determine the forms of energy that went into the use of each device?

Students should analyze their process and indicate how their conclusions related to tests they performed and observations they made.

How did you determine the forms of energy that came out of each device as it was used?

Students should analyze their process and indicate how their conclusions related to tests they performed and observations they made.

Does all of the energy that goes into each device come out as part of its function, or is some of the energy wasted? Support your answer with examples.

Students should conclude that some energy input is wasted in other forms. For example, some of the kinetic energy used to make a crank pencil sharpener function comes out as heat from friction.

Concept 3.1: Devices and Energy | 15

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3.1 | **Learn** What kinds of energy transfer must occur for light from the sun to power a cell phone?

Activity 7

Observe Like a Scientist

Quick Code: egs4261

The Conservation of Energy

Think about what you already know about changes in energy. Do you think energy can disappear or be used up? **Read** the text and **watch** the video to learn about **energy conservation**. Then, **answer** the questions that follow.

Video

You already know that energy can change and that there are many types of energy. Energy is constantly converted from one form or type to another. Consider this example: If you have ever ridden a bike, you are part of a series of events that involve energy conversion.

You eat breakfast so that the chemical energy in your food will give your body energy. As you push on the bike pedals with your legs, you cause the bike to move. You are changing chemical energy into mechanical energy. The mechanical energy in the bike is also becoming heat energy as the tires rub on the road.

Life Skills I can identify problems.

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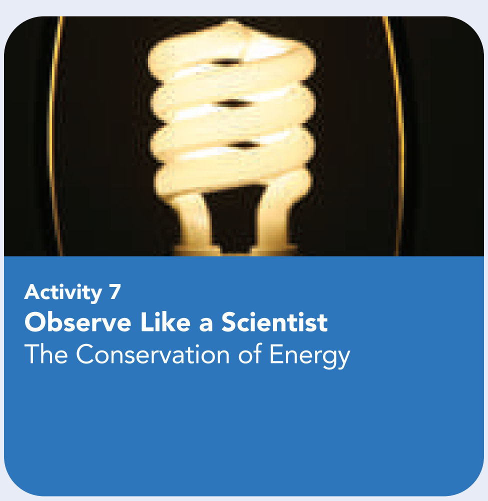

Quick Code: egst4261

Activity 7

Observe Like a Scientist

20 min

The Conservation of Energy

Purpose

To further understand energy transfer and to consider how fuels are used to generate the energy that devices rely on, students must understand the Law of Conservation of Energy.

Instructional Focus

In this activity, students read a text and watch a video about the conservation of energy. Students analyze information to explain what conservation of energy means and to identify examples of energy transfer.

Life Skills **Critical Thinking**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

ASK

- *Where does energy go when it changes?* *Energy can change forms, such as from kinetic to potential. It can also change from one type of energy to another.*
- *Can energy disappear or be used up?* *Student answers will vary depending upon their level of prior knowledge and understanding.*

Provide students time to read the text. After all students have completed the reading, check for understanding by asking if any students have questions.

Next, show students the video *The Conservation of Energy*.

Lesson 3, *continued*

Use the SOS strategy Pause and Play to allow students to reflect on the meaning of the video *The Conservation of Energy*. Consider explaining the strategy before beginning so that students know what to expect.

- First, play the full video once without pausing.
- Prepare students for the second viewing of the video by asking them to look for the definition of the conservation of energy (pause at 0:10).
- Next, tell students to discuss the different types of energy that are converted when a light bulb is turned on. (Play through the end of the video.)
- Finally, replay the video straight through without pausing to allow students to modify their answers.

SOS Pause and Play

Pause and Play is a teaching strategy that provides a structure to help students apply comprehension strategies to make sense of digital materials. Pausing the media at various points gives students multiple opportunities to monitor their comprehension.

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Here is another example of a different type of energy conversion. When you turn on a light bulb, you are starting an energy transformation. Electrical energy that powers the light bulb is converted into light and heat energy. The room becomes brighter with the light from the bulb. If you hold your hand near some light bulbs, you can feel their heat.

While energy can change forms, it never goes away. Energy cannot be created nor destroyed. This is the Law of Conservation of Energy. It means that new energy cannot simply be made from nothing, and old energy does not disappear. Energy just changes types and forms.

What is the definition of the phrase *conservation of energy*?

Energy cannot be created or destroyed. It just changes form.

What are the different forms of energy involved when a light bulb is turned on?

Electricity is converted to light and heat energy.

Concept 3.1: Devices and Energy | 17

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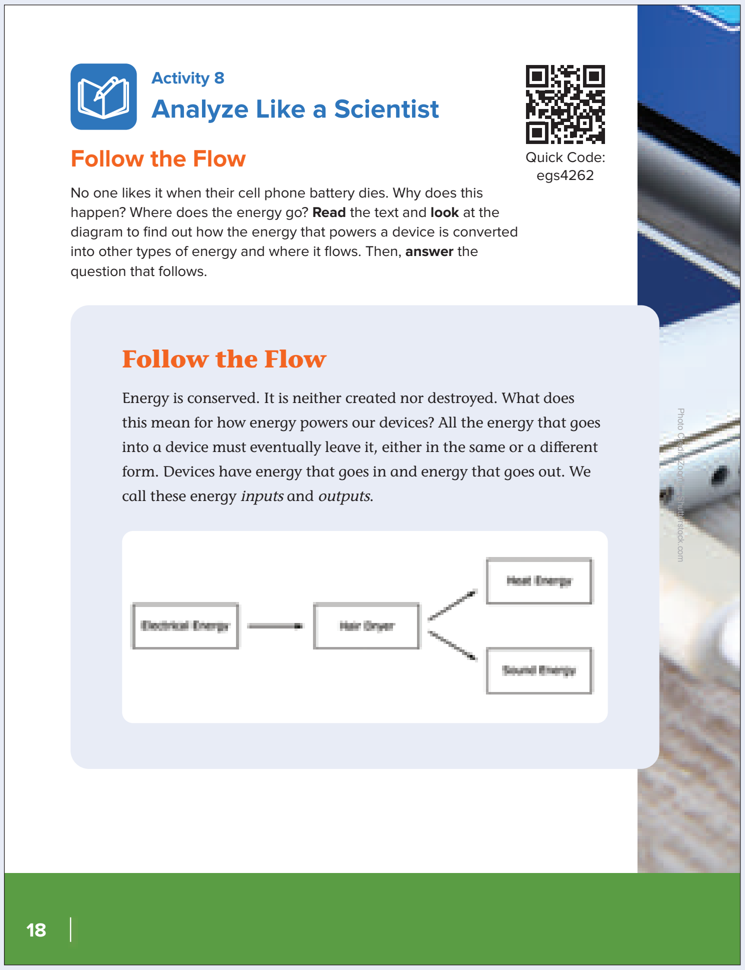

Activity 8

Analyze Like a Scientist

Follow the Flow

Quick Code: egs4262

No one likes it when their cell phone battery dies. Why does this happen? Where does the energy go? **Read** the text and **look** at the diagram to find out how the energy that powers a device is converted into other types of energy and where it flows. Then, **answer** the question that follows.

Follow the Flow

Energy is conserved. It is neither created nor destroyed. What does this mean for how energy powers our devices? All the energy that goes into a device must eventually leave it, either in the same or a different form. Devices have energy that goes in and energy that goes out. We call these energy *inputs* and *outputs*.

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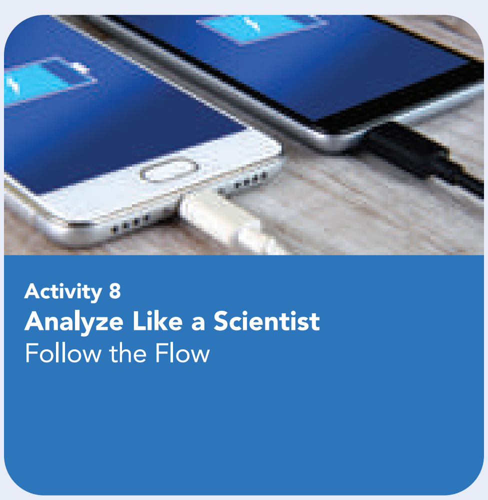

Quick Code:
egst4262

Lesson 4

Activity 8

Analyze Like a Scientist

10 min

Follow the Flow

Purpose

Now that students have learned about energy chains and the Law of Conservation of Energy, they are ready to connect the two ideas to interpret, and later construct, models of energy transfer.

Instructional Focus

In this activity, students track the flow of energy through common devices. Students use a flowchart to follow energy through a hair dryer and identify energy transfer in a cell phone.

Strategy

Read the text on energy flow within a device together as a class, using volunteer student readers.

After reading the first three paragraphs, ask students to use their fingers to trace the flow of energy into and out of the hair dryer diagram.

ASK *What could be added to the outputs in this diagram? What is missing?*
The diagram does not show the moving parts of the hair dryer or how the hair dryer transforms electrical energy in to heat and sound energy.

Lesson 4, *continued*

Next, have students read the final paragraph of the text. Challenge student pairs to list the different ways a cell phone uses its stored energy.

Students can represent their answers in writing or draw a diagram to represent the energy flow in a cell phone. If students struggle with examples of energy transformation, ask them to think about what functions someone can perform with a cell phone. For example, you can talk to someone on the phone, you can watch videos, and so on.

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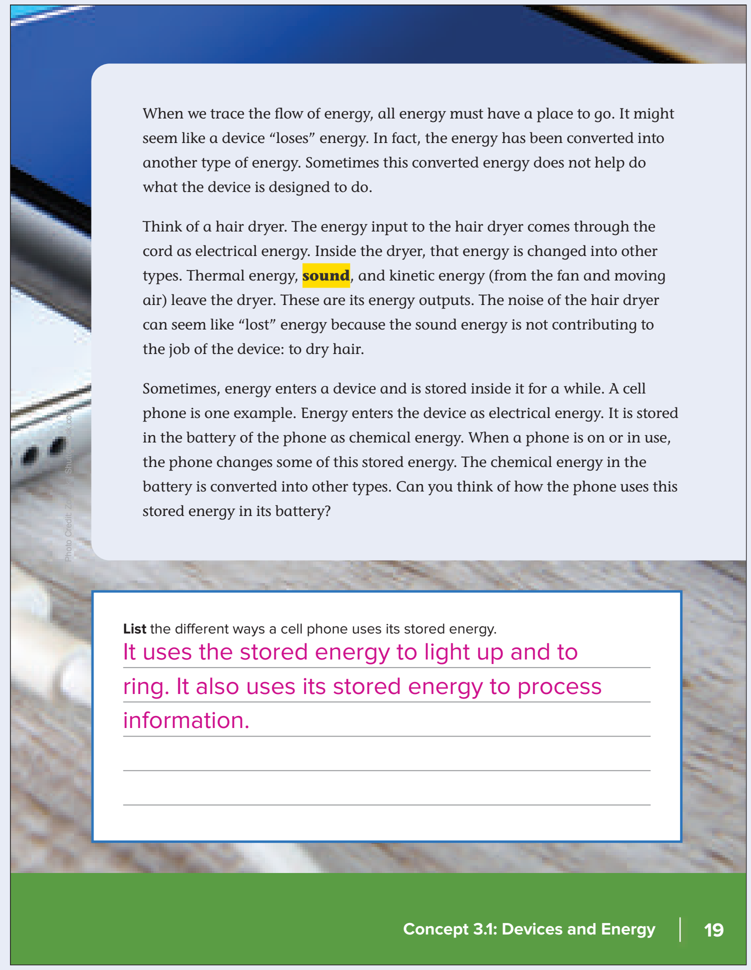

When we trace the flow of energy, all energy must have a place to go. It might seem like a device "loses" energy. In fact, the energy has been converted into another type of energy. Sometimes this converted energy does not help do what the device is designed to do.

Think of a hair dryer. The energy input to the hair dryer comes through the cord as electrical energy. Inside the dryer, that energy is changed into other types. Thermal energy, **sound**, and kinetic energy (from the fan and moving air) leave the dryer. These are its energy outputs. The noise of the hair dryer can seem like "lost" energy because the sound energy is not contributing to the job of the device: to dry hair.

Sometimes, energy enters a device and is stored inside it for a while. A cell phone is one example. Energy enters the device as electrical energy. It is stored in the battery of the phone as chemical energy. When a phone is on or in use, the phone changes some of this stored energy. The chemical energy in the battery is converted into other types. Can you think of how the phone uses this stored energy in its battery?

List the different ways a cell phone uses its stored energy.

It uses the stored energy to light up and to ring. It also uses its stored energy to process information.

Concept 3.1: Devices and Energy | 19

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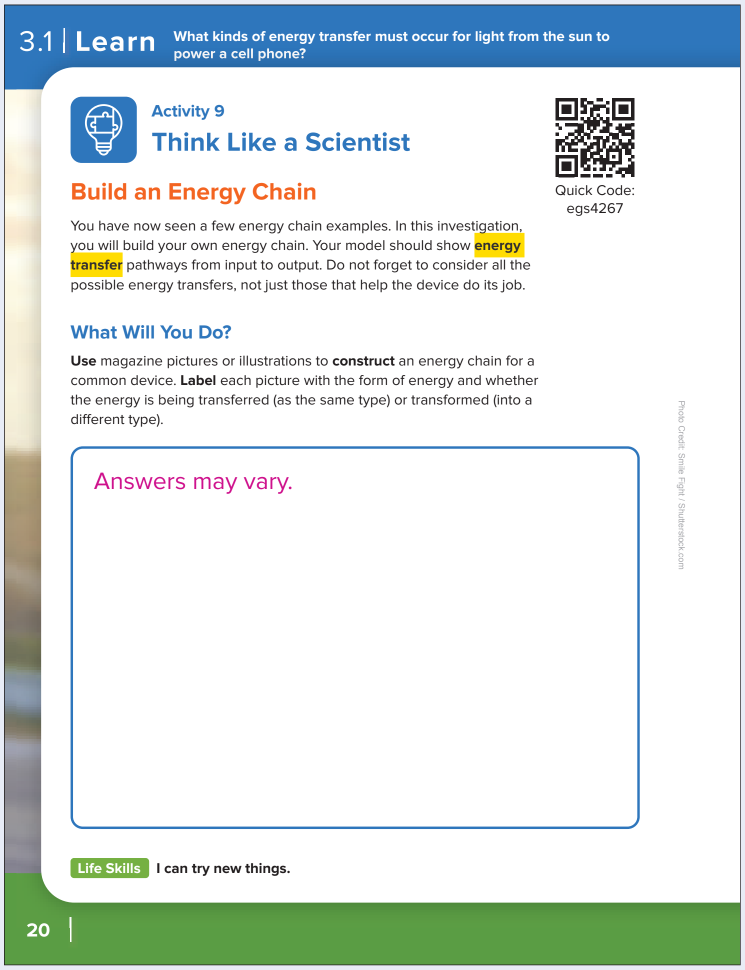

3.1 | Learn What kinds of energy transfer must occur for light from the sun to power a cell phone?

Activity 9

Think Like a Scientist

Build an Energy Chain

Quick Code: egs4267

You have now seen a few energy chain examples. In this investigation, you will build your own energy chain. Your model should show **energy transfer** pathways from input to output. Do not forget to consider all the possible energy transfers, not just those that help the device do its job.

What Will You Do?

Use magazine pictures or illustrations to **construct** an energy chain for a common device. **Label** each picture with the form of energy and whether the energy is being transferred (as the same type) or transformed (into a different type).

Answers may vary.

Life Skills I can try new things.

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Photo Credit: Vasilyev Alexandr / Shutterstock.com

DIGITAL

Activity 9

Think Like a Scientist

Build an Energy Chain

Quick Code: egst4267

Lesson 4, *continued*

Activity 9
Think Like a Scientist

20 min

Build an Energy Chain

Purpose

Students have analyzed a model of an energy chain and considered the various conversions (both intended and unintended) that can happen as devices operate. In this activity, students construct their own models.

Instructional Focus

In this activity, students model energy transfer pathways by creating an energy chain.

Life Skills **Endurance**

Activity Activator

To introduce the activity, discuss how the flow of energy can be modeled as an energy chain and how these models are useful for tracking energy pathways through different devices.

Lesson 4, *continued*

Activity Procedure: What Will You Do?

1. Have students make their own energy chains from magazine pictures on poster board.
2. Energy chains must consist of at least six pictures.
3. At least five of these pictures must be cut out of a magazine (one can be hand-drawn if a suitable magazine picture cannot be found).
4. For each picture, students should label the picture with the form of energy and indicate if the energy is being transferred or transformed.

If time allows, invite students to share their energy chains with the class. You may choose to conduct a Gallery Walk to allow students to share their work and summarize their learning. During a Gallery Walk, students display work around the room and then take turns walking around to view other students' designs.

Before beginning, ask students to share tips for how to provide feedback in a way that considers how their peers feel. Tips may include starting with positive feedback before offering suggestions or phrasing feedback in the form of a question ("Did you consider…?" or "What would happen if you added…?") instead of criticism ("You should have…").

Materials List (per group)

- Magazines
- Scissors
- Masking tape
- Sketch paper
- Poster board
- Colored pencils

Safety

- Follow all lab safety guidelines.
- Be careful using sharp objects, such as scissors.
- Follow proper disposal and cleaning procedures after the lab, including cleaning up any spills, scraps of paper, or stray glue.

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Think About the Activity

How can these types of models be used to track energy pathways?

Student responses should include that these models show how energy is transferred and transformed as it flows to, within, and out of devices.

What are the limitations of these types of models?

Student responses should include that these models are simplified. These types of models may not include some of the energy "lost" to factors such as friction or sound. Some details in the steps might also not be included.

Analysis and Conclusions: Think About the Activity

ASK

- *How can these types of models be used to track energy pathways?*
  Student responses should include that these models show how energy is transferred and transformed as it flows to, within, and out of devices.
- *What are the limitations of these types of models?*
  Student responses should include that these models are simplified. These types of models may not include some of the energy "lost" to factors such as friction or sound. Some details in the steps might also not be included.

Lesson 4, *continued*

Scientific Explanation

Activity 10
Record Evidence Like a Scientist

15 min

Energy in Remote-Controlled Cars

Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Instructional Focus

In this activity, students return to the Investigative Phenomenon and refine their responses to the Can You Explain? question.

Life Skills **Self-Management**

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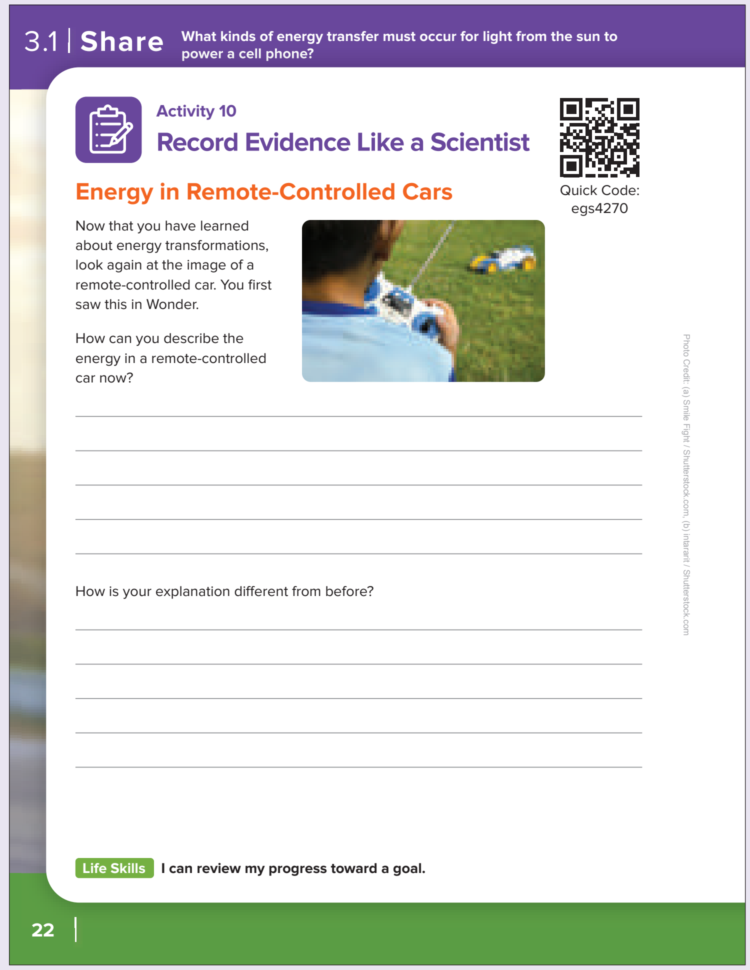

3.1 | Share What kinds of energy transfer must occur for light from the sun to power a cell phone?

Activity 10
Record Evidence Like a Scientist

Quick Code:
egs4270

Energy in Remote-Controlled Cars

Now that you have learned about energy transformations, look again at the image of a remote-controlled car. You first saw this in Wonder.

How can you describe the energy in a remote-controlled car now?

How is your explanation different from before?

Life Skills I can review my progress toward a goal.

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Photo Credit: intararit / Shutterstock.com

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Activity 10
Record Evidence Like a Scientist
Energy in Remote-Controlled Cars

Quick Code:
egst4270

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Look at the Can You Explain? question. You first read this question at the beginning of the lesson.

Can You Explain?

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Now, use your new ideas to write a scientific explanation to answer this question. First, **write** your claim. Your claim is a one sentence answer to the Can You Explain? question. It should not start with a yes or no.

My claim:
Forms of energy can be transformed into other forms of energy.

Concept 3.1: Devices and Energy | 23

Lesson 4, *continued*

Strategy

Display the Investigative Phenomenon of the Energy in Remote-Controlled Cars photo and the Can You Explain? question. Ask students to discuss, and share with the class or a partner, their explanation for the Investigative Phenomenon Energy in Remote-Controlled Cars.

ASK *How can this explanation help you answer the Can You Explain? question?*

Have students generate a scientific explanation to answer the Can You Explain? question.

Can You Explain?

What kinds of energy transfer must occur for light from the sun to power a cell phone?

Lesson 4, *continued*

Students should be familiar with the claim, reasoning, and evidence framework. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, what can you conclude? It should not start with *yes* or *no*.

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that does not support the claim.

Reasoning ties together the claim and the evidence and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

After providing scaffolding to the students, for those students able to do so, allow them to construct a full scientific explanation. Students can write, draw, or orally describe their claim and evidence.

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3.1 | Share — What kinds of energy transfer must occur for light from the sun to power a cell phone?

Next, **record** the evidence that supports your claim. Then, **explain** your reasoning.

Evidence	Reasoning That Supports Claim
We saw in our investigations that many of the devices we use every day need some type of energy to work. These devices can transform this energy into other forms of energy. For example, a table lamp takes electrical energy and transforms it into light and heat energy. Chemical energy in a battery is transformed into electrical energy to run a remote-controlled toy.	Almost all the energy we use comes from the sun. Energy from the sun can be converted into other forms of energy by technology.

Photo Credit: Smile Fight / Shutterstock.com

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Now, **write** your scientific explanation.

The energy transformations that must occur for light from the sun to power a cell phone are . . .

See sample student response in Teacher Materials.

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Optional Digital Activity 11

Analyze Like a Scientist

Careers and Energy in Systems

Go online to complete this activity.

Quick Code: egs4271

Optional Digital Activity 12

Evaluate Like a Scientist

Review: Devices and Energy

Go online to complete this activity.

Quick Code: egs4272

Concept 3.1: Devices and Energy | 25

Lesson 4, *continued*

Sample student response:

Almost all the energy we use originally comes from the sun. Forms of energy can be transformed into different forms of energy. We saw in our investigations that many of the devices we use every day need some type of energy to work. These devices can transform this energy into other forms of energy. For example, a table lamp takes electrical energy and transforms it into light and heat energy. Chemical energy in a battery is transformed into electrical energy to run a remote-controlled car. The energy from the sun is captured as chemical energy in sources like coal that can then be used to produce electricity at a power plant.

Optional Digital Activity 11

Analyze Like a Scientist

15 min

Careers and Energy in Systems

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code: egst4271

Optional Digital Activity 12

Evaluate Like a Scientist

15 min

Review: Devices and Energy

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code: egst4272

CONCEPT 3.2

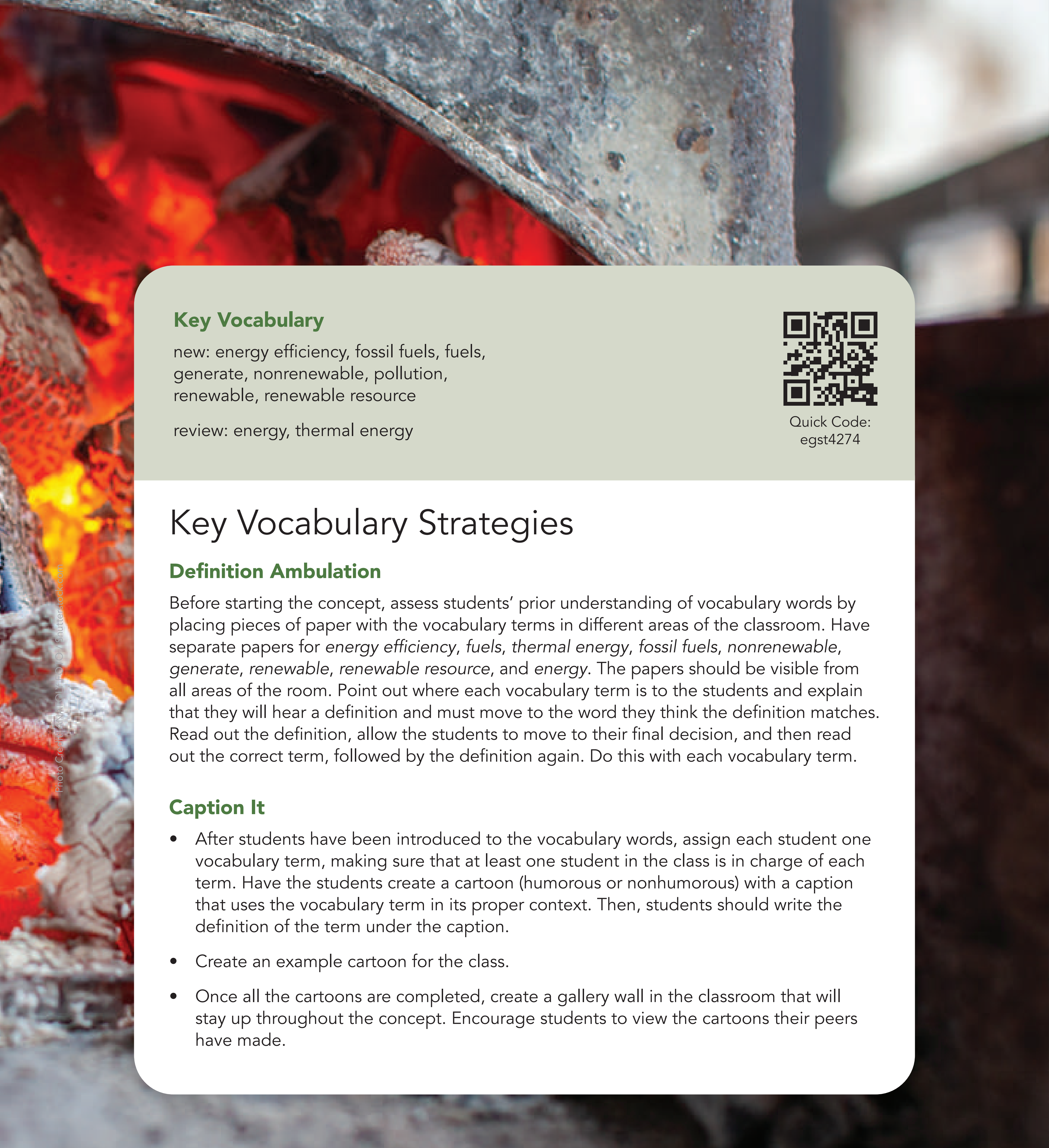
About Fuels

Concept Objectives

By the end of this concept, students should be able to:

- Develop models that describe patterns in the formation of different types of fossil fuels from natural resources and that predict the properties and uses of different types of fossil fuels.
- Obtain and combine information to describe how the use of energy and fuels affects the environment.

Quick Code:
egst4273



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Key Vocabulary

new: energy efficiency, fossil fuels, fuels, generate, nonrenewable, pollution, renewable, renewable resource

review: energy, thermal energy

Quick Code:
egst4274

Key Vocabulary Strategies

Definition Ambulation

Before starting the concept, assess students' prior understanding of vocabulary words by placing pieces of paper with the vocabulary terms in different areas of the classroom. Have separate papers for *energy efficiency*, *fuels*, *thermal energy*, *fossil fuels*, *nonrenewable*, *generate*, *renewable*, *renewable resource*, and *energy*. The papers should be visible from all areas of the room. Point out where each vocabulary term is to the students and explain that they will hear a definition and must move to the word they think the definition matches. Read out the definition, allow the students to move to their final decision, and then read out the correct term, followed by the definition again. Do this with each vocabulary term.

Caption It

- After students have been introduced to the vocabulary words, assign each student one vocabulary term, making sure that at least one student in the class is in charge of each term. Have the students create a cartoon (humorous or nonhumorous) with a caption that uses the vocabulary term in its proper context. Then, students should write the definition of the term under the caption.
- Create an example cartoon for the class.
- Once all the cartoons are completed, create a gallery wall in the classroom that will stay up throughout the concept. Encourage students to view the cartoons their peers have made.

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Wonder	Lesson 1	Activity 1	5 min
		Activity 2	20 min
		Activity 3	20 min
Learn	Lesson 2	Activity 4	30 min
		Activity 6	15 min
	Lesson 3	Activity 7	10 min
		Activity 8	15 min
		Activity 9	20 min
	Lesson 4	Activity 10	20 min
		Activity 11	25 min
	Lesson 5	Activity 12	20 min
		Activity 14	25 min
Share	Lesson 6	Activity 15	20 min
		Activity 17	25 min

Content Background

When teaching children about traditional versus modern methods of power generation, it is important to teach both the advantages and drawbacks of each. Giving students the skills to become the innovators and problem solvers of the future means educating them both about how things have been done in the past and how technology is evolving to improve both our environment and our way of life.

Natural Resources

Humans have long relied on Earth's natural resources to provide both energy and materials. Natural resources include things such as soil, fuels, water, minerals, and air. Over time, humans have learned how to convert the energy contained in some of these natural resources into usable forms of energy, such as electricity. Some natural resources, such as fossil fuels and minerals, are finite in amount and take thousands or millions of years to form. Once they are used up, they are gone until lengthy Earth processes create more. Other resources, such as plant materials, wind, and solar energy, have their origins in the sun and are essentially unlimited. The former are considered nonrenewable, while the latter are considered renewable. Once a ton of coal is burned, it cannot be replaced without waiting for millions of years. Wood from trees, on the other hand, can be replaced by planting new trees. While use of renewable resources is on the rise, nonrenewable resources still provide approximately 84 percent of our world's energy supply.

Energy from Fossil Fuels

Fossil fuels are the most important source of energy in our modern world. Fossil fuels (coal, oil, gas) are derived from the remains of ancient plants and animals. Since they are relatively cheap and currently plentiful, fossil fuels are currently the world's main source of energy. The energy in fossil fuels is chemical energy stored in the remains of once-living organisms. The energy is released as heat when the fuel is burned. That heat is then transformed into other forms of energy, such as kinetic energy (for example, car motion). The transfer of heat (from burning fuel) into water and steam drives turbines within electric power plants and leads to the generation of electricity that powers our world.

Types of Fossil Fuels

Coal is one of the most abundant fossil fuels and is formed from the remains of plants that lived up to 400 million years ago. As they decayed, these plants turned into peat, which is rich in carbon. Over time, layers of accumulating sediment applied more and more pressure to the peat. This pressure squeezed water from the peat, leaving behind a mostly carbon, energy-rich substance. As the peat became buried and exposed to the heat below Earth's surface, it gradually turned to coal. About half of the coal burned for energy is used to produce electricity.

Content Background, *continued*

Oil is another common fossil fuel used around the world. Oil is formed from the remains of animals that died 10 million to 160 million years ago and became buried on the ocean floor. As additional layers of sediment buried the remains, pressure and heat turned the decayed organisms into crude oil. Where oil is found, natural gas is almost always also found. Natural gas is the cleanest-burning fossil fuel.

Challenges with Fossil Fuels

Fossil fuels are used for home energy use, generation of electricity, and transportation. Consumers worldwide most often use fossil fuels indirectly—in the energy used to produce and process raw materials and transport products.

The demand for fossil fuels outpaces the supply in today's world, so it is important to stress fossil fuel conservation and the development of alternative fuel sources, such as solar and wind power. Because much of our fossil fuel use is in the form of production and transportation of products, conservation involves not only using less energy directly but also consuming less.

Lesson 1

Activity 1
Can You Explain?

5 min

Where does the fuel we use every day come from?

Purpose

In this activity, students build upon their knowledge of energy chains and how energy can be traced back to the sun. Students begin thinking about the source of fuels, for example the fuels used in cars and trucks.

Instructional Focus

Students describe what they already know about the source of fuels used every day. Students are encouraged to explain the source in detail and add information they may know about other fuels and their sources.

Life Skills **Endurance**

Strategy

Encourage students to explain what they know about where the fuel we use every day, such as in cars and trucks, comes from. Challenge students to think about other fuels and their sources. Student answers are not expected to be fully formed at this point.

Students may have some initial ideas about how to answer the question (see sample student response in the Student Materials). By the end of the concept, students should be able to construct a scientific explanation that includes evidence from the concept activities.

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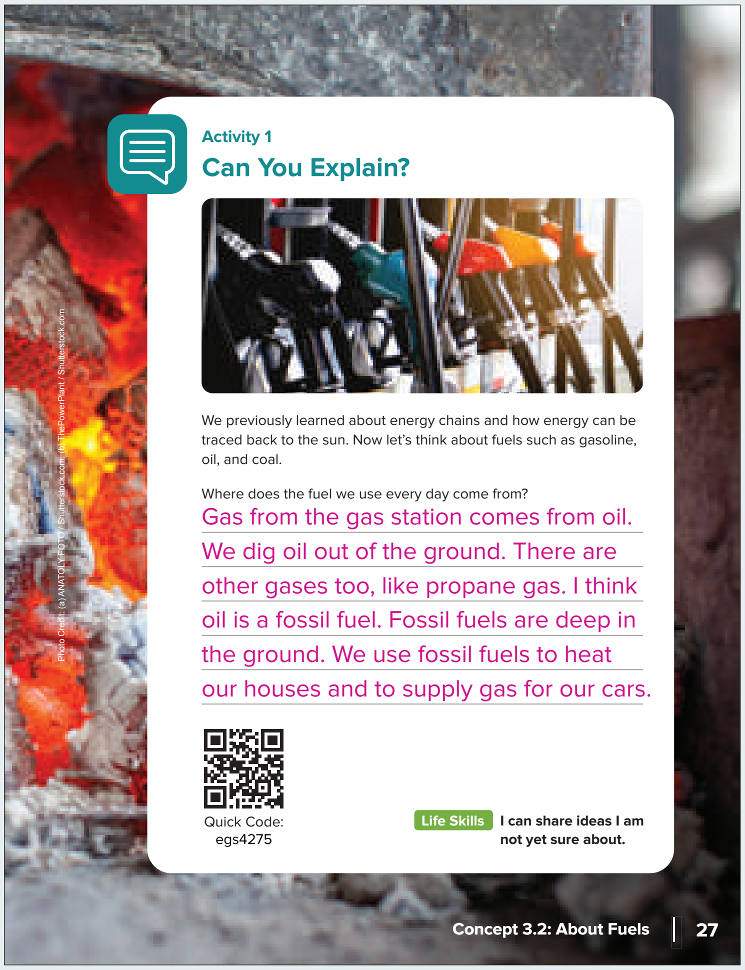
Activity 1
Can You Explain?

We previously learned about energy chains and how energy can be traced back to the sun. Now let's think about fuels such as gasoline, oil, and coal.

Where does the fuel we use every day come from?

Gas from the gas station comes from oil. We dig oil out of the ground. There are other gases too, like propane gas. I think oil is a fossil fuel. Fossil fuels are deep in the ground. We use fossil fuels to heat our houses and to supply gas for our cars.

Quick Code: egs4275

Life Skills I can share ideas I am not yet sure about.

Concept 3.2: About Fuels | 27

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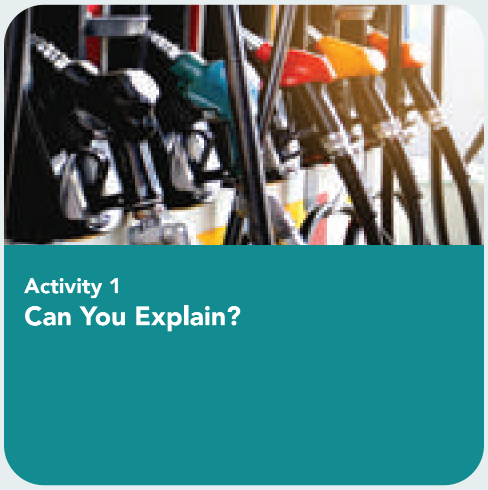

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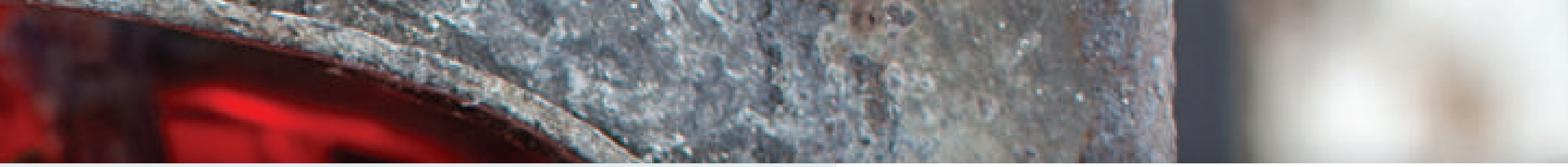

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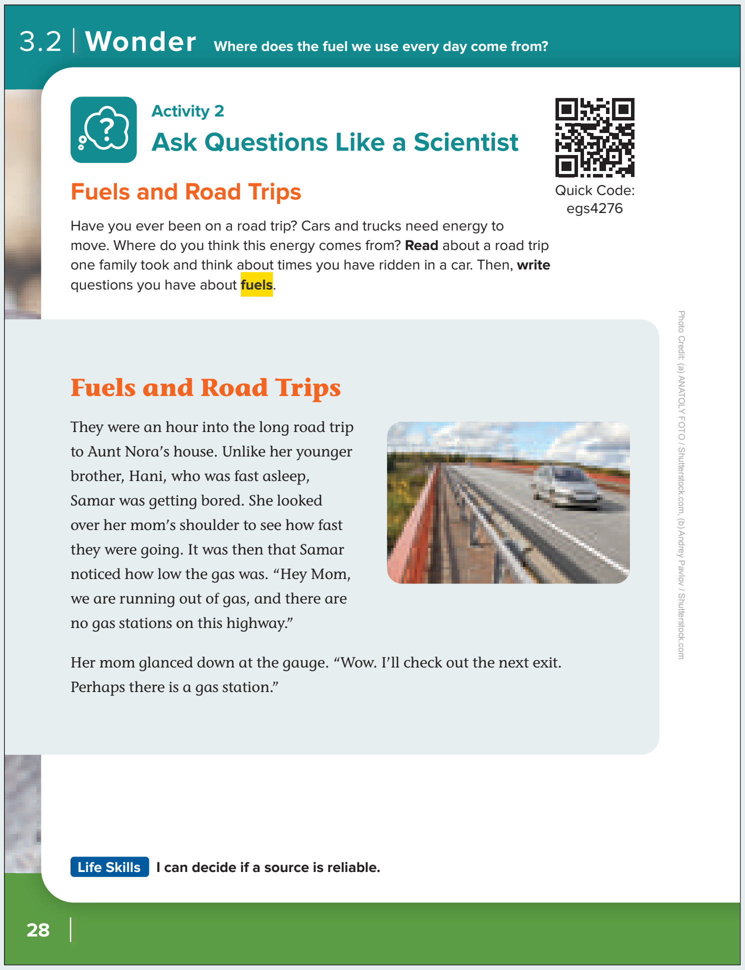
3.2 | **Wonder** Where does the fuel we use every day come from?

Activity 2

Ask Questions Like a Scientist

Quick Code: egs4276

Fuels and Road Trips

Have you ever been on a road trip? Cars and trucks need energy to move. Where do you think this energy comes from? **Read** about a road trip one family took and think about times you have ridden in a car. Then, **write** questions you have about fuels.

Fuels and Road Trips

They were an hour into the long road trip to Aunt Nora's house. Unlike her younger brother, Hani, who was fast asleep, Samar was getting bored. She looked over her mom's shoulder to see how fast they were going. It was then that Samar noticed how low the gas was. "Hey Mom, we are running out of gas, and there are no gas stations on this highway."

Her mom glanced down at the gauge. "Wow. I'll check out the next exit. Perhaps there is a gas station."

Life Skills I can decide if a source is reliable.

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Photo Credit: Andrey Pavlov / Shutterstock.com

DIGITAL

Activity 2

Ask Questions Like a Scientist

Fuels and Road Trips

Quick Code: egst4276

Investigative Phenomenon

Activity 2

Ask Questions Like a Scientist

20 min

Fuels and Road Trips

Purpose

The Investigative Phenomenon presents an engaging scenario—sometimes familiar and sometimes unfamiliar—to spark student curiosity about the world around them. In this activity, students think about taking a road trip and the fuel used.

Instructional Focus

In this activity, students access prior knowledge about fuel and generate questions related to fuel.

Life Skills **Critical Thinking**

Strategy

Introduce this concept by using the example of a road trip to generate a discussion around how we use fuel. The text can be used to help students recall their own experiences around using fuel.

Lesson 1, *continued*

After students read the text, have them discuss what they know about the properties of gasoline. Students' observations may include the ease of dispensing the liquid at the gas station into the car, its flammability, and the understanding that when gasoline is burned, most of the products are gases. Some students may also mention pollutants. The impact of fuels on the environment is not a focus of this concept, but consider keeping their ideas about pollution in reserve for later in the unit. Ask students to think of, write down, and share questions they would like to investigate about the different types of fuels, where they come from, and how we use them.

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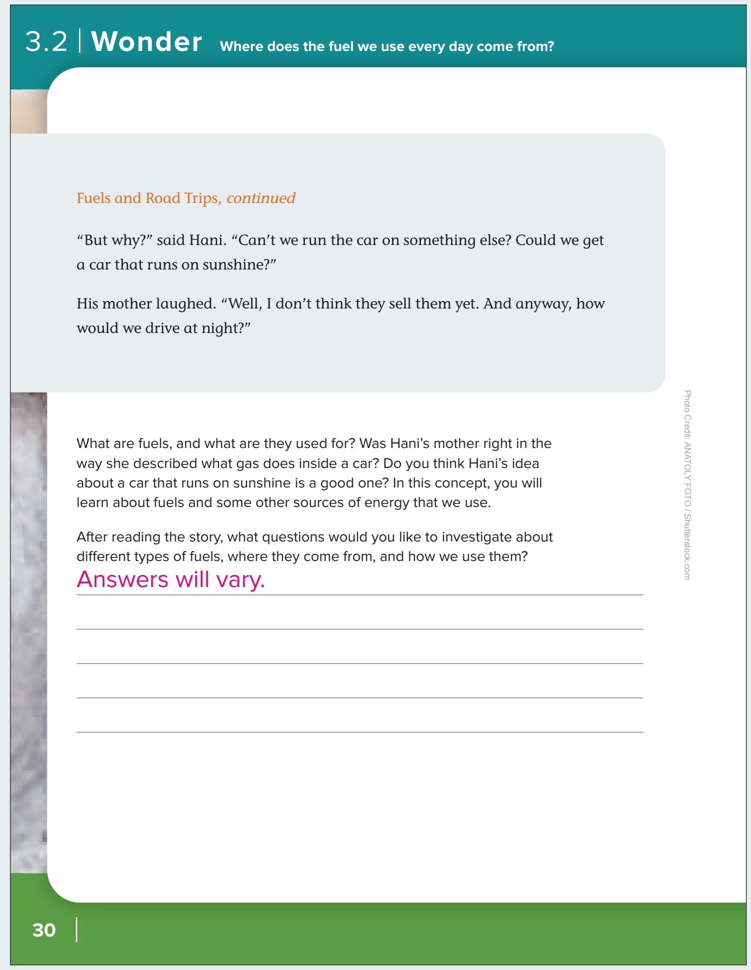

3.2 | Wonder Where does the fuel we use every day come from?

Fuels and Road Trips, *continued*

"But why?" said Hani. "Can't we run the car on something else? Could we get a car that runs on sunshine?"

His mother laughed. "Well, I don't think they sell them yet. And anyway, how would we drive at night?"

What are fuels, and what are they used for? Was Hani's mother right in the way she described what gas does inside a car? Do you think Hani's idea about a car that runs on sunshine is a good one? In this concept, you will learn about fuels and some other sources of energy that we use.

After reading the story, what questions would you like to investigate about different types of fuels, where they come from, and how we use them?

Answers will vary.

Photo Credit: ANATOLY FOTO / Shutterstock.com

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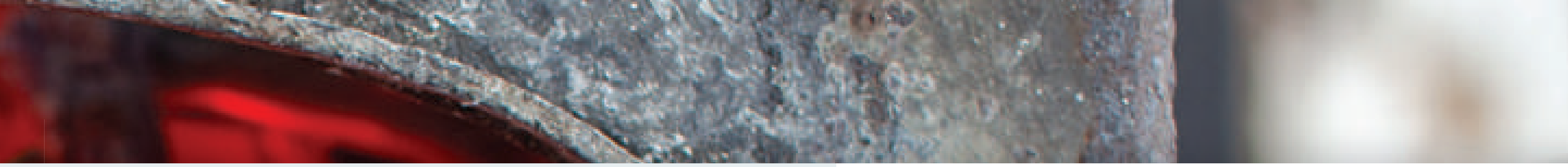

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Activity 3

Evaluate Like a Scientist

What Do You Already Know About Fuels?

Quick Code:
egs4277

Fuels We Use

We use fuels in many different ways every day. Does your family need fuel to cook or heat your home? Let's think about different fuels, where they come from, and how they can be used as energy. **Choose** one of the fuels pictured here and be ready to share your ideas.

Gasoline

Natural Gas

Coal

Wood

Concept 3.2: About Fuels | 31

DIGITAL

Quick Code:
egst4277

Lesson 1, *continued*

Activate Prior Knowledge

Activity 3
Evaluate Like a Scientist

20 min

What Do You Already Know About Fuels?

Purpose

This interactive activity is a formative assessment of students' understanding of fuels, what they are used for, and how they can be used as energy.

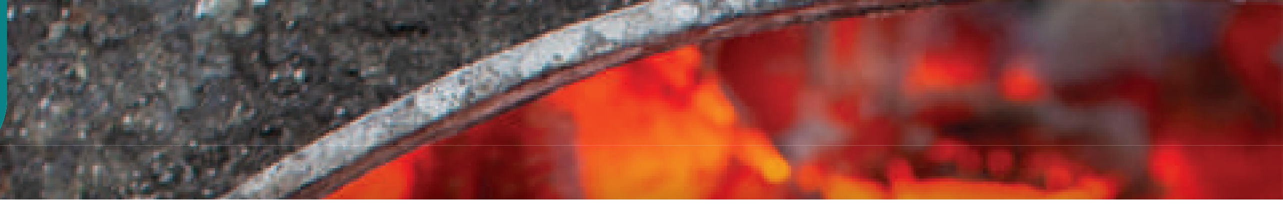
Instructional Focus

In this formative assessment, students describe current knowledge of ways in which a specific fuel is used and how it can be used as energy.

Fuels We Use

Strategy

This item provides a formative assessment of students' existing knowledge of specific fuels and how they are used as energy. Challenge students to think about input and output of the energy chains.



Lesson 1, *continued*

Four Corners

Assign each corner of the room to one of the fuels pictured in the Student Materials. You may wish to post a sign identifying each fuel. Direct students to choose a fuel from the four listed in the Student Materials: gasoline, wood, coal, or natural gas. As students move to the appropriate corner of the room, direct students to share what they know about the fuel, including where it comes from, the ways it is used, and how it might fit into an energy chain. Ask the questions suggested below or add more of your own to promote discussion. Student answers may not be fully formed at this point, but this activity will give you a better idea of student prior knowledge.

ASK

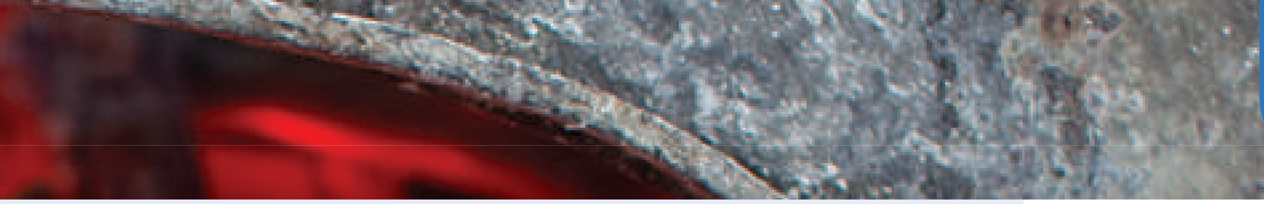
- *Share some ideas about where your fuel comes from.*
- *How is your fuel used as energy?*
- *Can you trace one of the energy chains for your fuel?*

If time remains after students have discussed within their groups, direct students to choose one person from their group to share the information with the other groups.

Teacher Reflection

Based on my data:

- What content do my students already know?
- What misconceptions do my students have at this point in the course?
- Are any of my students ready for extension at this point in the lesson?



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What Are the Different Types of Fuels?

Activity 4
Analyze Like a Scientist

Quick Code: egs4278

Types of Fuel

Have you ever wondered about the different types of fuels we use? **Watch** the video and **read** the text with a partner to learn about different types of fuels and where they come from. Then, **classify** the information on the graphic organizer and respond to the questions.

Types of Fuel

Fuels are substances that, when burned, release thermal energy. Wood is the most ancient fuel and is still widely used throughout the world. A wide variety of plant and other materials are used for fuels. Because they are made from living things, they are called biofuels. For example, charcoal, made from wood, is an important fuel.

Cooking Using Charcoal

Life Skills I can identify problems.

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DIGITAL

Activity 4
Analyze Like a Scientist
Types of Fuel

Quick Code:
egst4278

Lesson 2

What Are the Different Types of Fuels?

Activity 4
Analyze Like a Scientist

30 min

Types of Fuel

Purpose

The text in this activity provides information on how various fuel sources are formed and introduces the difference between renewable and nonrenewable energy sources. This introduction builds a foundation for a subsequent in-depth study of energy resources.

Instructional Focus

In this activity, students read a scientific text about the matter and energy flow of biofuels and fossil fuels and how the materials can be extracted to use as an energy source.

Life Skills **Critical Thinking**

Lesson 2, *continued*

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Use the video and text Types of Fuel as a resource for students to gather evidence about the difference between and the usefulness of biofuels and fossil fuels.

- Ask students to work with a partner to read the text, such as reading alternating paragraphs. After reading and discussing the article, direct students to classify information on the graphic organizer according to biofuels or fossil fuels.
- Finally, use an equitable calling technique, such as choosing from a set of premade name cards, to call on students to discuss the following questions. Students may not have a fully formed scientific answer at this point. Encourage creativity in their thinking.

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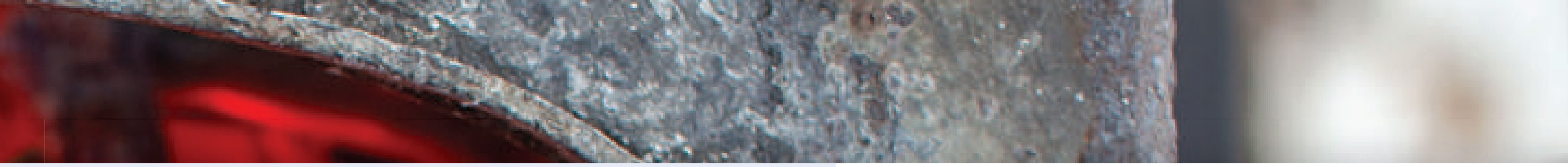
	Biofuels	Fossil Fuels
Definition	Student answers may vary. Sample answer: Fuel made from living things that can be grown.	Student answers may vary. Sample answer: Fuel made from the remains of living things that takes millions of years to form under very specific conditions.
Examples	Wood, grass, corn	Coal, oil, gasoline, natural gas
Renewable or Nonrenewable	Renewable	Nonrenewable

Concept 3.2: About Fuels | 35



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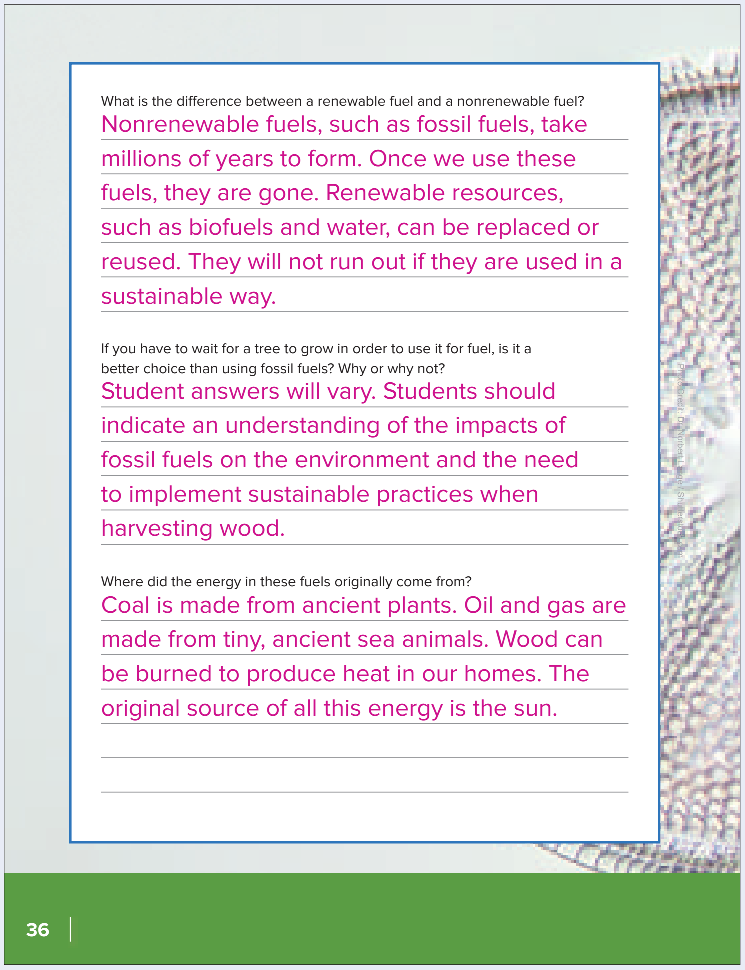

What is the difference between a renewable fuel and a nonrenewable fuel?
Nonrenewable fuels, such as fossil fuels, take millions of years to form. Once we use these fuels, they are gone. Renewable resources, such as biofuels and water, can be replaced or reused. They will not run out if they are used in a sustainable way.

If you have to wait for a tree to grow in order to use it for fuel, is it a better choice than using fossil fuels? Why or why not?
Student answers will vary. Students should indicate an understanding of the impacts of fossil fuels on the environment and the need to implement sustainable practices when harvesting wood.

Where did the energy in these fuels originally come from?
Coal is made from ancient plants. Oil and gas are made from tiny, ancient sea animals. Wood can be burned to produce heat in our homes. The original source of all this energy is the sun.

36

Lesson 2, *continued*

ASK

- *What is the difference between a renewable fuel and a nonrenewable fuel?*
  Nonrenewable fuels, such as fossil fuels, take millions of years to form. Once we use these fuels, they are gone. Renewable resources, such as biofuels and water, can be replaced or reused. They will not run out if they are used in a sustainable way.
- *If you have to wait for a tree to grow in order to use it for fuel, is it a better choice than using fossil fuels? Why or why not?*
  Student answers will vary. Students should indicate an understanding of the impacts of fossil fuels on the environment and the need to implement sustainable practices when harvesting wood.
- *Where did the energy in these fuels originally come from?*
  Coal is made from ancient plants. Oil and gas are made from tiny, ancient sea animals. Wood can be burned to produce heat in our homes. The original source of all this energy is the sun.

Differentiation

APPROACHING LEARNERS

For extra support, break the text reading into chunks of one paragraph each and read each paragraph together as a class. Have a class discussion after each paragraph, and check for understanding by asking questions about the content and having students locate and highlight the answers in the text.

Lesson 2, *continued*

Optional Digital Activity 5
Observe Like a Scientist

20 min

Fossil Fuels

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code:
egst4281

Activity 6
Analyze Like a Scientist

15 min

Oil and Water

Purpose
Previously, students learned where various fuel sources come from and determined whether the sources are renewable or nonrenewable. In this activity, students focus on oil and water and consider ways to conserve these energy resources.

Instructional Focus
In this activity, students obtain information about the differences between water and oil as energy resources.

Strategy
Students should read the text describing the formation of oil. The class has now seen a few examples of nonrenewable energy resources. Students should recognize that both heat and pressure play a role in the formation of both coal and oil (fossil fuels).

PRINT
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Optional Digital Activity 5
Observe Like a Scientist
Fossil Fuels
Go online to complete this activity.
Quick Code:
egs4281

Activity 6
Analyze Like a Scientist
Oil and Water
Oil and water are two types of resources that humans can use to generate power. However, these two energy resources have many differences. **Read** the text. Then, **answer** the questions that follow.
Quick Code:
egs4282

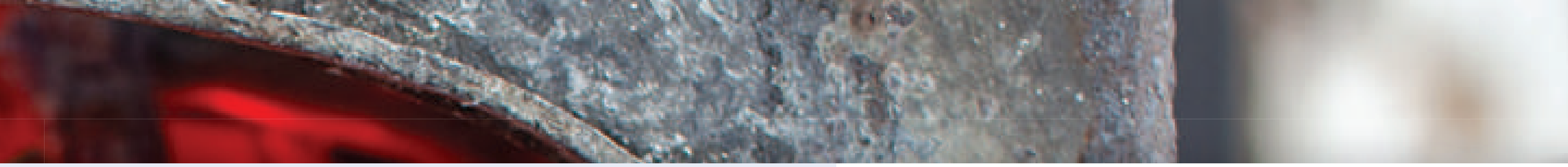
Oil and Water
Oil comes from deep in the ground. Scientists think that oil formed from the decomposition of sea creatures. As the sea creatures died, their remains settled on the ocean floor. They became covered with layers of sediment and rock.

Sea Creature under a Microscope

Concept 3.2: About Fuels | 37

DIGITAL

Quick Code:
egst4282



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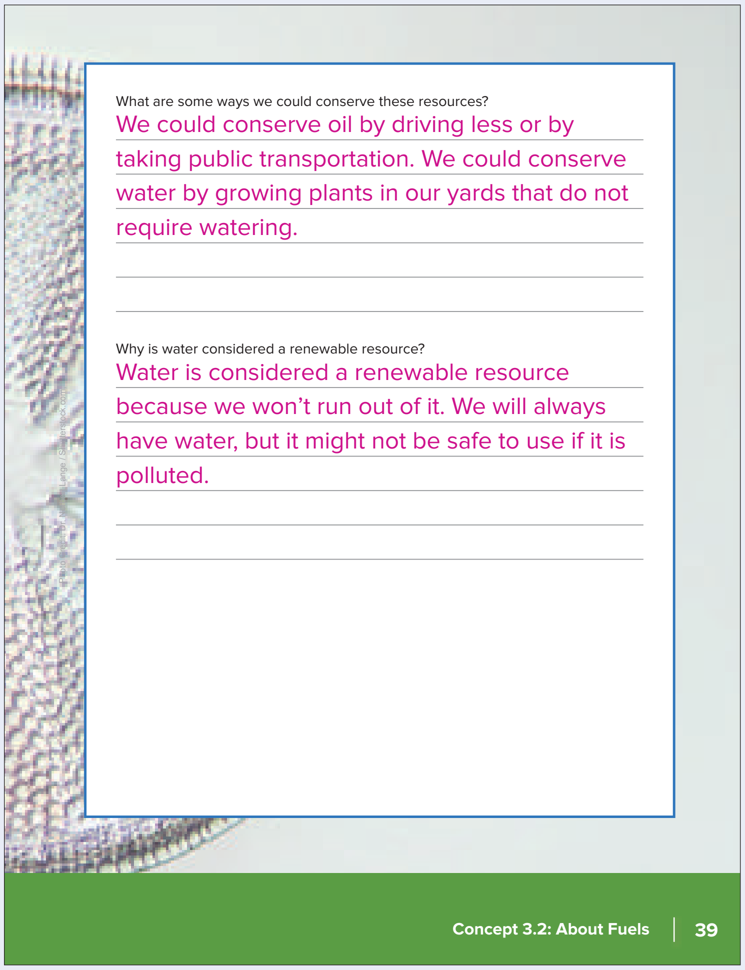

What are some ways we could conserve these resources?

We could conserve oil by driving less or by taking public transportation. We could conserve water by growing plants in our yards that do not require watering.

Why is water considered a renewable resource?

Water is considered a renewable resource because we won't run out of it. We will always have water, but it might not be safe to use if it is polluted.

Concept 3.2: About Fuels | 39

Lesson 2, *continued*

Ask students to consider what would happen if we ran out of nonrenewable resources.

ASK

- *What are some ways we could conserve these resources?*
  We could conserve oil by driving less or by taking public transportation. We could conserve water by growing plants in our yards that do not require watering.
- *Why is water considered a renewable resource?*
  Water is considered a renewable resource because we won't run out of it. We will always have water, but it might not be safe to use if it is polluted.

MISCONCEPTION

Some students may think that fossil fuels are made of dinosaur bones or other large animal fossils. Students may also think that any fossil can become coal, oil, or natural gas. In fact, only certain types of organisms, preserved under certain conditions, become fossil fuels. Coal forms from plant matter. Oil and natural gas are formed from the remains of marine plankton (very tiny organisms).

Lesson 3

Activity 7
Evaluate Like a Scientist

10 min

Fossil Fuel Formation

Purpose

Students have learned about various fossil fuel resources, such as coal, oil, and natural gas. In this formative assessment, students sequence the order of steps needed for the formation of fossil fuels to better understand the extensive amount of time it takes for them to form.

Instructional Focus

In this activity, students summarize their learning and communicate knowledge of the process involved in the formation of fossil fuels.

Life Skills **Decision-Making**

Strategy

The item Fossil Fuel Formation provides a formative assessment of students' understanding of how fossil fuels are formed. Students should draw on evidence collected during previous activities to support their sequencing of the formation of fossil fuels.

Students should know that there are different types of fossil fuel resources (for example: coal, oil, natural gas). However, students may not understand the process by which these energy sources are formed. Have students work in pairs to make any necessary corrections.

To encourage student discussion, complete this item as a Four Corners activity. Print out each step of creating fossil fuels on a separate sheet of paper. Create signs to label four corners of your classroom. Ask students to walk to the first step in the process. If there is not consensus among the class, ask a representative from each corner to convince the others that they are correct. After a representative speaks, allow students to change their answer if they would like. Repeat this with the rest of the steps, then provide students time to record answers to the item Fossil Fuel Formation.

PRINT

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3.2 | Learn Where does the fuel we use every day come from?

Activity 7
Evaluate Like a Scientist

Quick Code: egs4283

Fossil Fuel Formation

Let's see if you understand how fossil fuels form. The following are the steps involved in the formation of fossil fuels. **Write** them in the correct order.

Remains changed to become coal, oil, and natural gas.
Remains were buried.
Living things that lived a long time ago died.
Heat and pressure affected the remains.

Living things that lived a long time ago died.
Remains were buried.
Heat and pressure affected the remains.
Remains changed to become coal, oil, and natural gas.

Life Skills I can decide on a solution to use.

40

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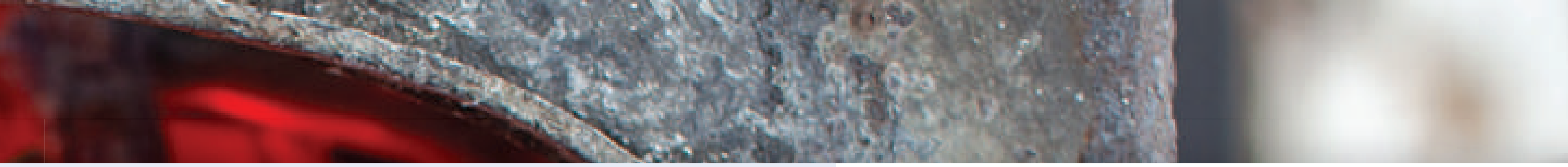
Activity 7
Evaluate Like a Scientist
Fossil Fuel Formation

Quick Code: egst4283



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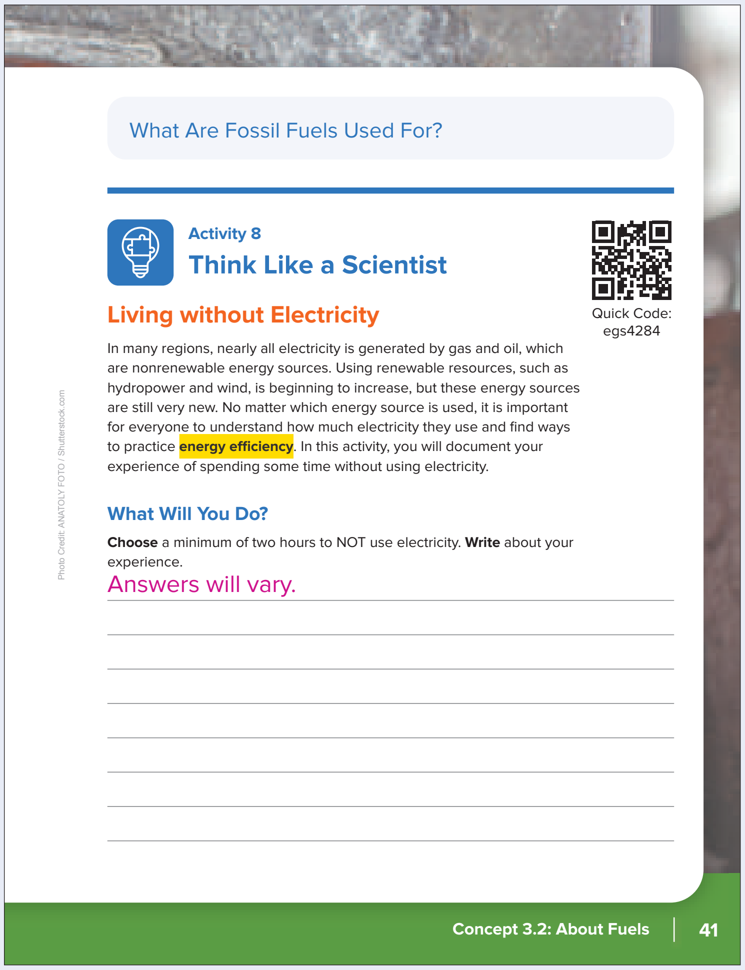

What Are Fossil Fuels Used For?

Activity 8
Think Like a Scientist

Living without Electricity

Quick Code: egs4284

In many regions, nearly all electricity is generated by gas and oil, which are nonrenewable energy sources. Using renewable resources, such as hydropower and wind, is beginning to increase, but these energy sources are still very new. No matter which energy source is used, it is important for everyone to understand how much electricity they use and find ways to practice **energy efficiency**. In this activity, you will document your experience of spending some time without using electricity.

What Will You Do?

Choose a minimum of two hours to NOT use electricity. **Write** about your experience.

Answers will vary.

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Concept 3.2: About Fuels | 41

DIGITAL

Activity 8
Think Like a Scientist
Living without Electricity

Quick Code:
egst4284

Lesson 3, *continued*

What Are Fossil Fuels Used For?

Activity 8
Think Like a Scientist

15 min

Living without Electricity

Purpose

Earlier in this concept, students explained what they know about natural resources that are used as fuels. This activity reinforces the importance of conserving natural resources commonly used to generate electricity. Students begin to identify ways they can contribute to conservation efforts.

Instructional Focus

In this activity, students spend a period of time without using electricity to draw attention to possible ways to conserve energy.

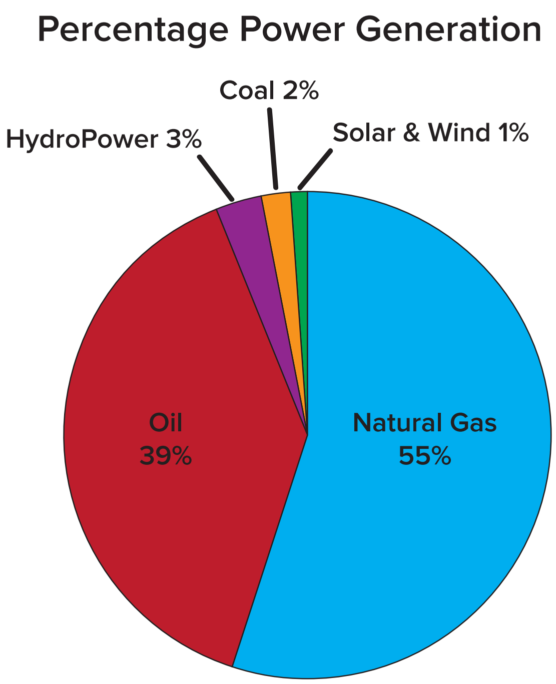
Activity Activator

In this activity, students spend a period of time without using electricity. Students document their experience. To introduce the activity, show students the chart showing the breakdown of electricity sources in Egypt. If students are unfamiliar with pie charts, explain that a pie chart is a visual way to compare parts of a whole. In this pie chart, the "slices" visualize how much of total energy consumption in Egypt comes from each type of fuel.

In Egypt, nearly all electricity is generated by gas and oil, yet use of renewable resources is a priority and is beginning to increase. Discuss with students the percentages of electricity sources provided below to highlight the relevance of this activity.

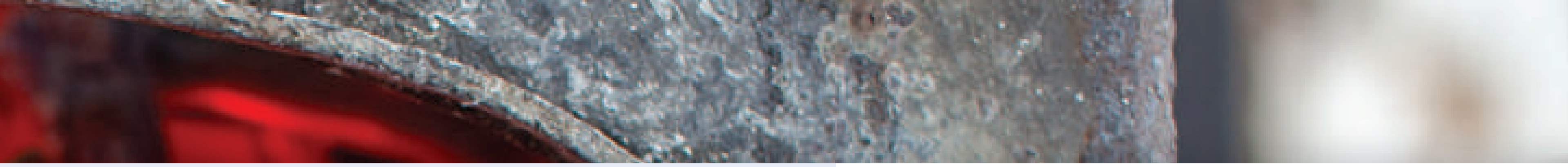
Lesson 3, *continued*

Introduce the first part of this activity to students, and then encourage students to gather information at home, possibly over the weekend. Then, proceed to the next activity. Once students have had time to collect data, revisit the lesson and discuss their findings as a group.



Activity Procedure: What Will You Do?

1. Ask students to choose a period of time (at least two hours) when they will not use any electricity at home.
   - Advise students that this must be a period when they would normally be using electricity (in other words, not when they are sleeping).
   - Emphasize the importance of safety, such as not walking around too much in the dark if performing this activity at night, and asking an adult for help if they decide to use candles for light.
   - Be sure that students understand that battery-operated devices count as using electricity. This includes cell phones and laptop computers.
   - Encourage students to actively keep a record of the experience in a notebook while they are avoiding using electricity. If they are doing this activity in the dark, have them document the experience as soon as they have turned the lights back on.
2. Assign the Think About the Activity questions once students have completed the investigation to document their experience.
3. You may wish to hold a class discussion after students have completed the activity. Ask volunteers to share their thoughts and feelings about their experiences.



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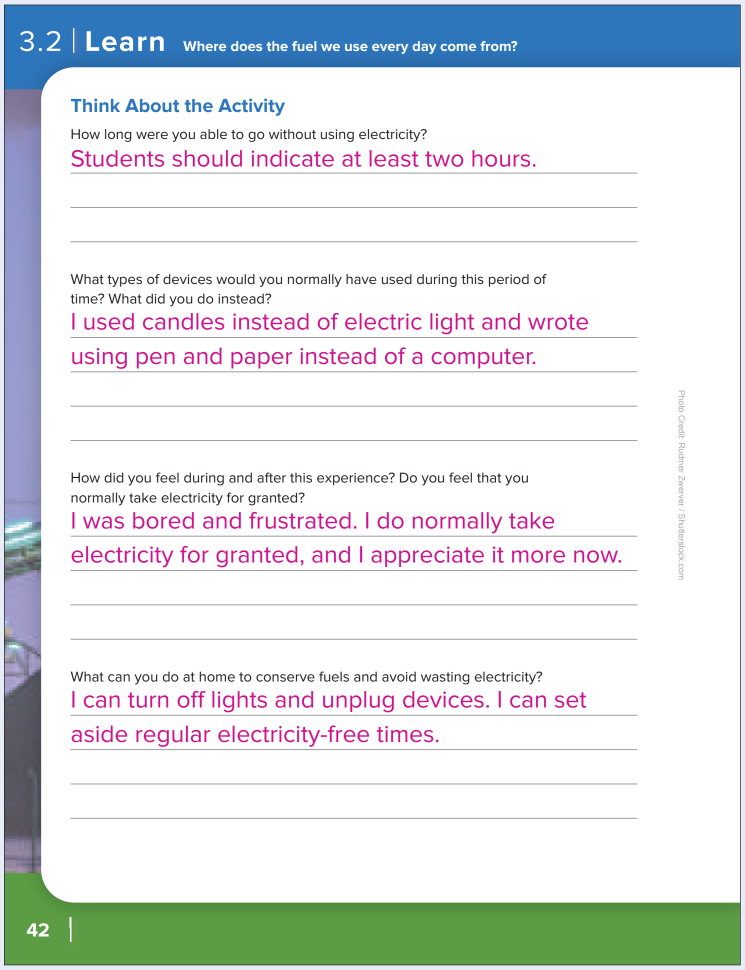

3.2 | **Learn** Where does the fuel we use every day come from?

Think About the Activity

How long were you able to go without using electricity?
Students should indicate at least two hours.

What types of devices would you normally have used during this period of time? What did you do instead?
I used candles instead of electric light and wrote using pen and paper instead of a computer.

How did you feel during and after this experience? Do you feel that you normally take electricity for granted?
I was bored and frustrated. I do normally take electricity for granted, and I appreciate it more now.

What can you do at home to conserve fuels and avoid wasting electricity?
I can turn off lights and unplug devices. I can set aside regular electricity-free times.

Photo Credit: Rudmer Zwerver / Shutterstock.com

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Analysis and Conclusions: Think About the Activity

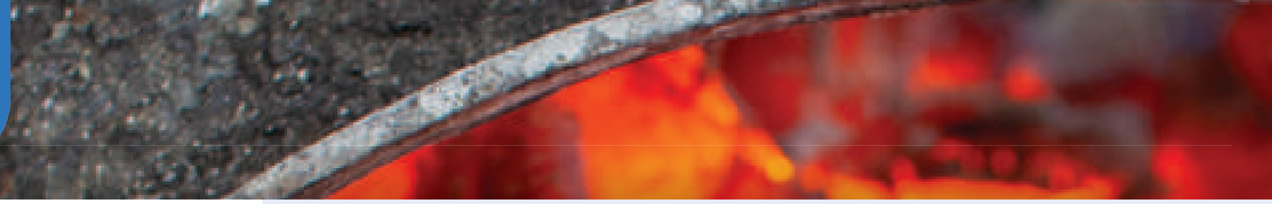
ASK

- *How long were you able to go without using electricity?*
  Students should note the period of time they had set as their goal and how long they actually went without using electricity.

- *What types of devices would you normally have used during this period of time? What did you do instead?*
  Students should give examples of devices they normally use during that period of time, such as cell phones, lights, televisions, computers, etc., and describe what they did instead when not using electricity. For example, students may have used candles instead of electric lights or taken notes using pen and paper when they would normally have used a computer.

- *How did you feel during and after this experience? Do you feel that you normally take electricity for granted?*
  Students should describe how they felt during and after the experience. They may have felt bored or frustrated during the experience and relieved afterward. They may feel that they normally take electricity for granted and now appreciate it more.

- *What can you do at home to conserve fuels and avoid wasting electricity?*
  Students should give examples of how they can use less electricity at home, such as turning off lights, unplugging devices, or setting aside regular electricity-free periods.



Lesson 3, *continued*

Activity 9
Analyze Like a Scientist

20 min

Using Fossil Fuels to Generate Electricity

Purpose

Previously, students explained what they know about natural resources that are used as fuels. This activity connects fuel use to electricity generation and reinforces the importance of conserving natural resources.

Instructional Focus

In this activity, students develop a model depicting the flow of energy from fossil fuels to an electric device in the home.

Strategy

Direct students to read the text to deepen their understanding of how fossils fuels are used to generate electricity. Using a model that depicts the flow of energy from a fossil fuel through a power plant to an electric device in their home will help students make sense of the complex text. After reading the first paragraph once, ask students to reread it and then identify and label each component of the power plant on the diagram as it is described. The role of steam in moving turbines and turbines in moving generators will be important throughout the rest of the unit.

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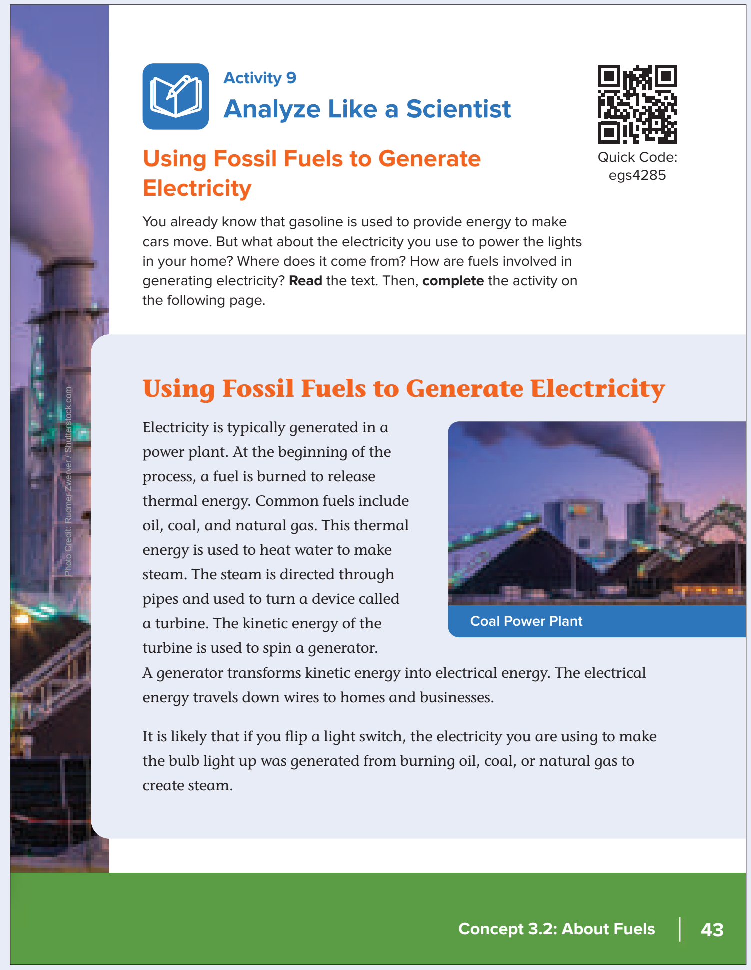

Activity 9
Analyze Like a Scientist

Using Fossil Fuels to Generate Electricity

Quick Code:
egs4285

You already know that gasoline is used to provide energy to make cars move. But what about the electricity you use to power the lights in your home? Where does it come from? How are fuels involved in generating electricity? **Read** the text. Then, **complete** the activity on the following page.

Using Fossil Fuels to Generate Electricity

Electricity is typically generated in a power plant. At the beginning of the process, a fuel is burned to release thermal energy. Common fuels include oil, coal, and natural gas. This thermal energy is used to heat water to make steam. The steam is directed through pipes and used to turn a device called a turbine. The kinetic energy of the turbine is used to spin a generator.

Coal Power Plant

A generator transforms kinetic energy into electrical energy. The electrical energy travels down wires to homes and businesses.

It is likely that if you flip a light switch, the electricity you are using to make the bulb light up was generated from burning oil, coal, or natural gas to create steam.

Concept 3.2: About Fuels | 43

Photo Credit: Rudmer Zwerver / Shutterstock.com

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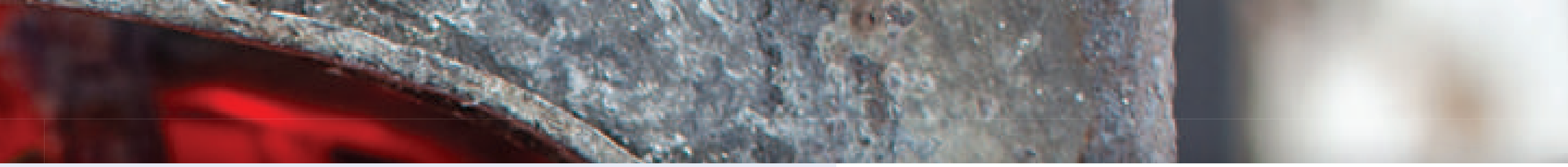
Activity 9
Analyze Like a Scientist
Using Fossil Fuels to Generate Electricity

Quick Code:
egst4285



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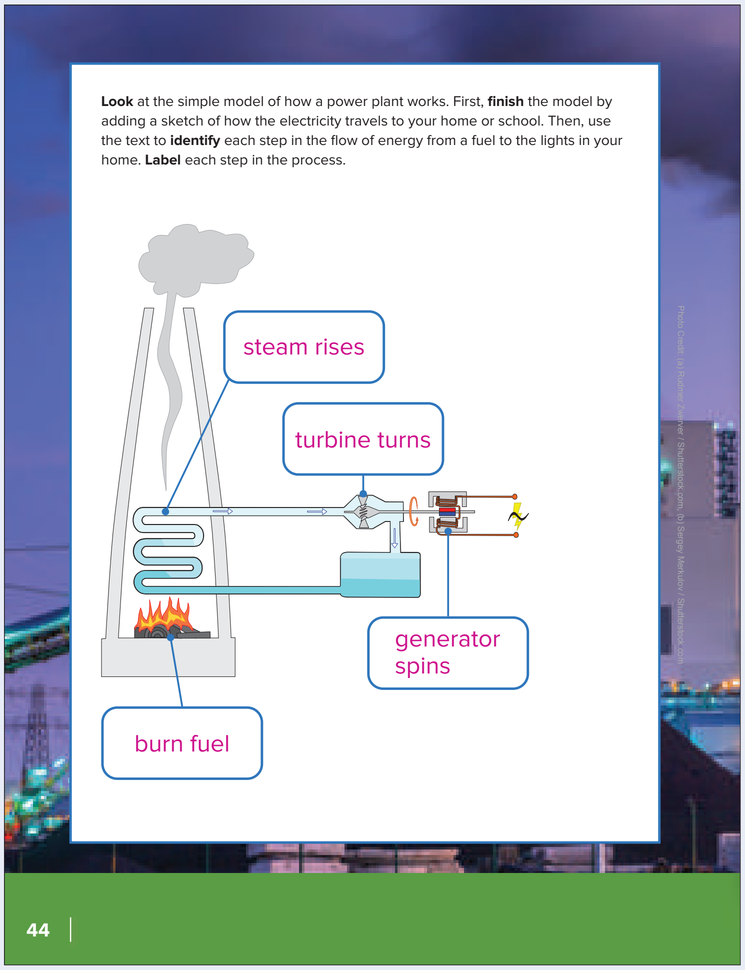

Lesson 3, *continued*

Differentiation

ADVANCED LEARNERS

Ask advanced learners to create a more expansive model showing how energy from the sun contributes to the formation of coal and how coal is used to generate electricity used to power electric devices in the home.

Lesson 4

Activity 10
Observe Like a Scientist

20 min

Big City Environmental Concerns

Purpose

Students have learned about how fossil fuels can be used to power cars or generate electricity. Students now explore a negative effect of fossil fuel use: air pollution in big cities.

Instructional Focus

In this activity, students watch a video and discuss some causes and effects of air pollution in cities.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning. Ask students to watch the video *Big City Environmental Concerns*, which focuses on air pollution in Mexico City, Mexico.

PRINT

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Activity 10

Observe Like a Scientist

Big City Environmental Concerns

Quick Code: egs4330

Using fossil fuels can have negative impacts on the environment. **Read** the text, **watch** the video, and **look** for reasons why big cities have air pollution problems.

Video

Population demands and increased industry and agriculture have resulted in pollution problems around the world. Burning fuels for energy can pollute the air. Pesticides used in farms can be carried into streams when it rains. The chemicals used at many factories can pollute the air as well as nearby water and soil.

Pollution, in the form of smog, is especially severe in large cities. Environmental concerns are being addressed in large cities worldwide, where smog from automobile emissions causes widespread irritation to eyes and lungs. Medical researchers have found that smog is full of small particles that we breathe in. Because these pollutants are so small, they can irritate our lungs and damage the tissue of the respiratory system. Efforts to make laws to prevent high smog levels in large cities are making slow progress.

Talk Together Now, talk together about the sources of air pollution in big cities. What is the potential impact of air pollution on the respiratory system?

Photo Credit: (a) Rudmer Zwerver / Shutterstock.com, (b) Svetlana Bykova /Shutterstock.com, (c) Icon made by Freepik from www.flaticon.com

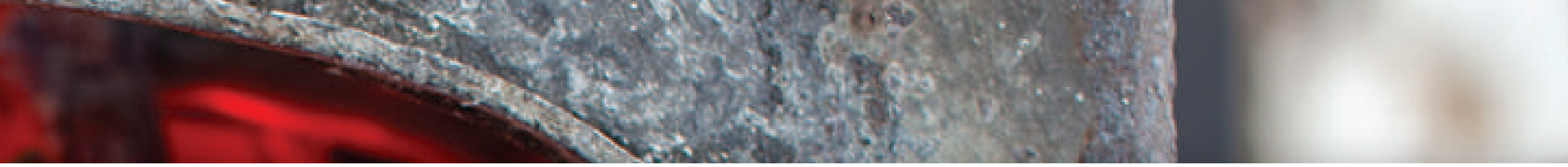
Concept 3.2: About Fuels | 45

DIGITAL

Activity 10
Observe Like a Scientist
Big City Environmental Concerns

Quick Code:
egst4330

Photo Credit: Svetlana Bykova / Shutterstock.com



Lesson 4, *continued*

- Students should look for why big cities often have serious air pollution issues.
- After students watch the video, direct pairs or small groups to identify two or three sources of air pollution in big cities. Encourage a few pairs to share their sources.
- Then, elicit the effects of each source of pollution from the class. Discuss the connections between what they have learned of the respiratory system in prior units and the impact of air pollution on our health.

Lesson 4, *continued*

Activity 11
Analyze Like a Scientist

25 min

Burning Fossil Fuels and Pollution

Purpose

Students learn how burning fossil fuels can negatively affect the environment by creating acid rain and adding to global warming.

Instructional Focus

In this activity, students communicate cause-and-effect relationships between burning fossil fuels and the impact on the environment.

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Activity 11
Analyze Like a Scientist
Burning Fossil Fuels and Pollution
Quick Code: egs4331
What happens when fossil fuels are burned to release energy? **Read** the text. As you read, **complete** the graphic organizer at the end of the passage to show how burning fossil fuels affects the environment.

Burning Fossil Fuels and Pollution

In the 1800s, people began to need more energy than ever before. They needed energy to run factories, cars, trains, and ships.

Since then, the demand for energy has continued to rise. More energy is needed to supply electricity to homes, schools, businesses, and factories. The problem has always been finding a way to get all this energy.

Power Plant Emissions

The solution was fossil fuels. Fossil fuels include coal, oil, and natural gas. Burning fossil fuels releases energy. People can use this energy to make things work. For example, people can burn coal or oil in a power plant. They can use the energy from the fuel to produce electricity. Then, they send the electricity through power lines to homes, schools, and factories.

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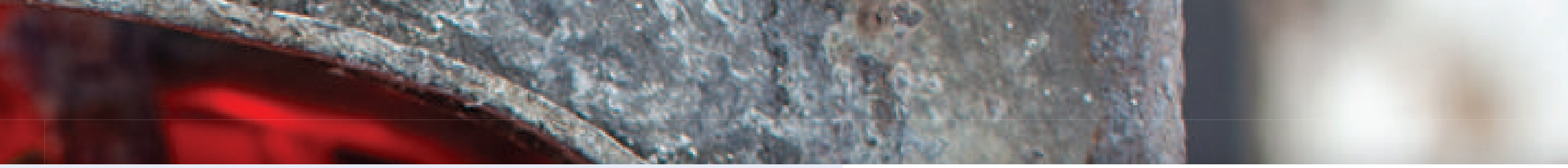
Activity 11
Analyze Like a Scientist
Burning Fossil Fuels and Pollution

Quick Code:
egst4331

Photo Credit: Idphotoro / Shutterstock.com



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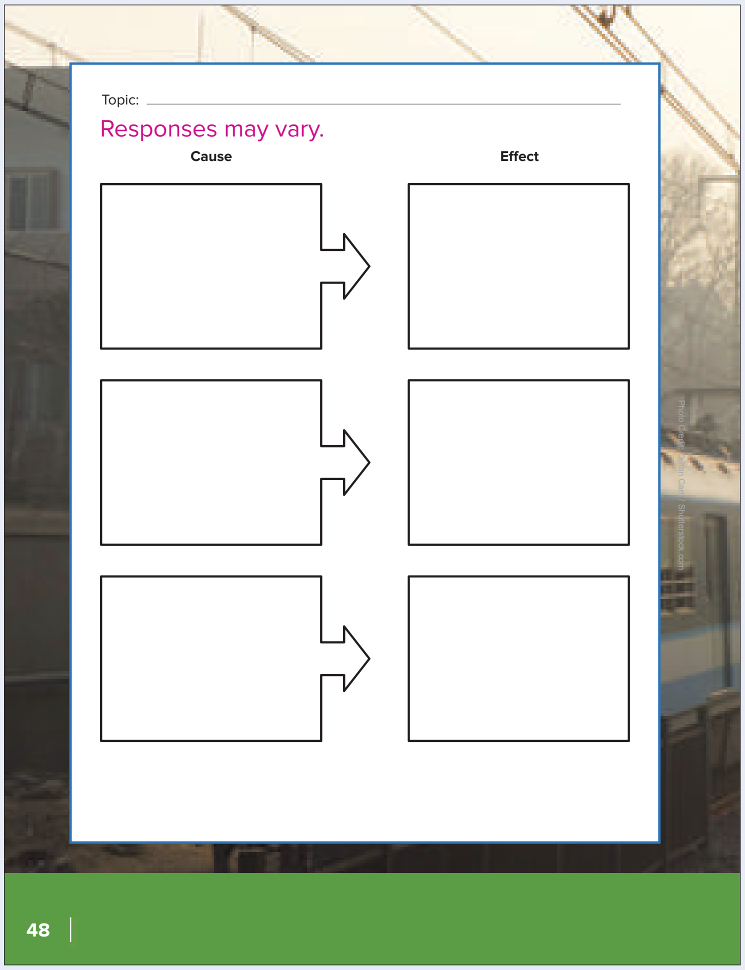

Topic:

Responses may vary.

Cause	Effect

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Lesson 4, *continued*

Strategy

Assign students to read the text about how burning fossil fuels pollutes the air and water. Ask them to create a cause-and-effect graphic organizer that shows how burning fossil fuels affects the environment.

Review student responses to the graphic organizer. Sample responses are shown below.

Cause:
The burning of fossil fuels releases carbon dioxide and water vapor into the air.

Effect:
Climate change

Cause:
The burning of fossil fuels releases harmful gases into the air.

Effect:
Acid rain changes the chemistry of lakes and dissolves rocks.

Lesson 5

Why Is It Important to Use Fossil Fuels Wisely?

Activity 12
Analyze Like a Scientist

20 min

Conserving Fossil Fuels

Purpose

Students now understand how fossil fuels can be used to generate electricity. In this activity, students will learn about some of the drawbacks to relying on nonrenewable sources of energy and why energy conservation is important.

Instructional Focus

In this activity, students identify the main ideas of a text that describes resource conservation and discuss the importance of conserving energy.

Strategy

During an earlier class session, students had the opportunity to think about life without electricity. Facilitate a conversation to elicit students' early ideas about why conserving electricity might be important.

ASK

- *How can we conserve electricity at home or school?*
  Compile a list of students' ideas.
- *Why do you think it is important that we try to conserve energy?*
  Student answers may vary but may include concerns about the cost of energy, the availability of energy, and the environmental impact of energy use on the planet.

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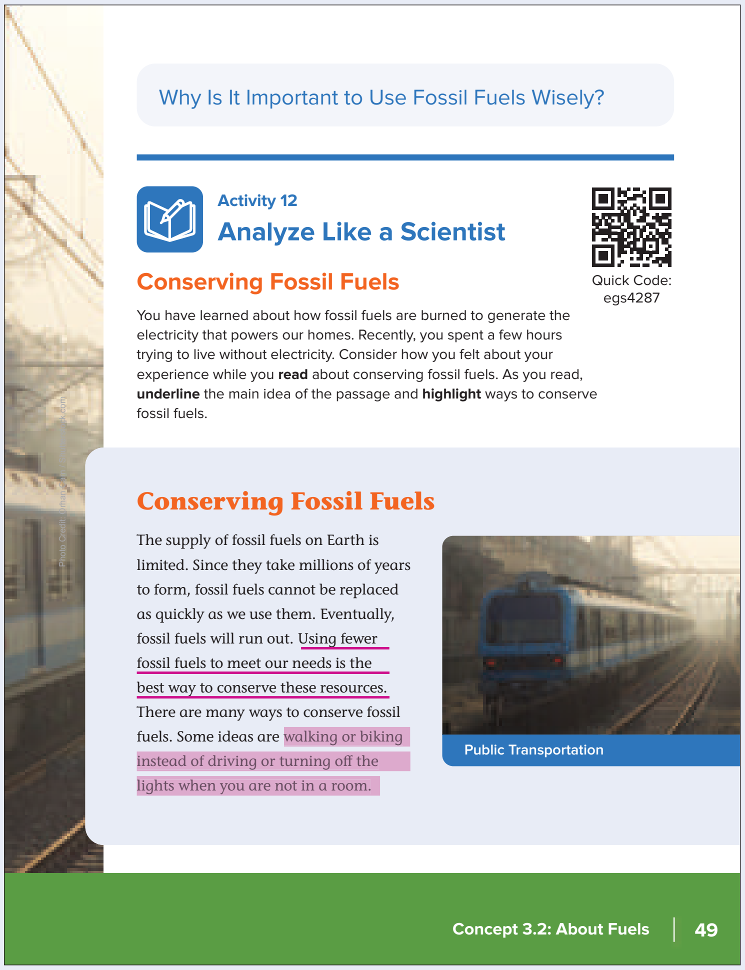
Why Is It Important to Use Fossil Fuels Wisely?

Activity 12
Analyze Like a Scientist

Quick Code: egs4287

Conserving Fossil Fuels

You have learned about how fossil fuels are burned to generate the electricity that powers our homes. Recently, you spent a few hours trying to live without electricity. Consider how you felt about your experience while you **read** about conserving fossil fuels. As you read, **underline** the main idea of the passage and **highlight** ways to conserve fossil fuels.

Conserving Fossil Fuels

The supply of fossil fuels on Earth is limited. Since they take millions of years to form, fossil fuels cannot be replaced as quickly as we use them. Eventually, fossil fuels will run out. Using fewer fossil fuels to meet our needs is the best way to conserve these resources. There are many ways to conserve fossil fuels. Some ideas are walking or biking instead of driving or turning off the lights when you are not in a room.

Public Transportation

Concept 3.2: About Fuels | 49

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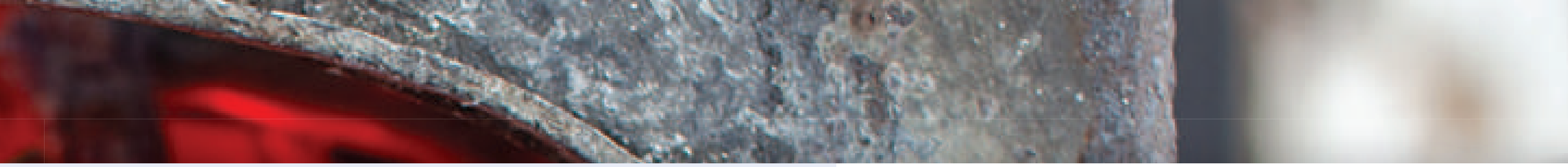
Activity 12
Analyze Like a Scientist
Conserving Fossil Fuels

Quick Code:
egst4287



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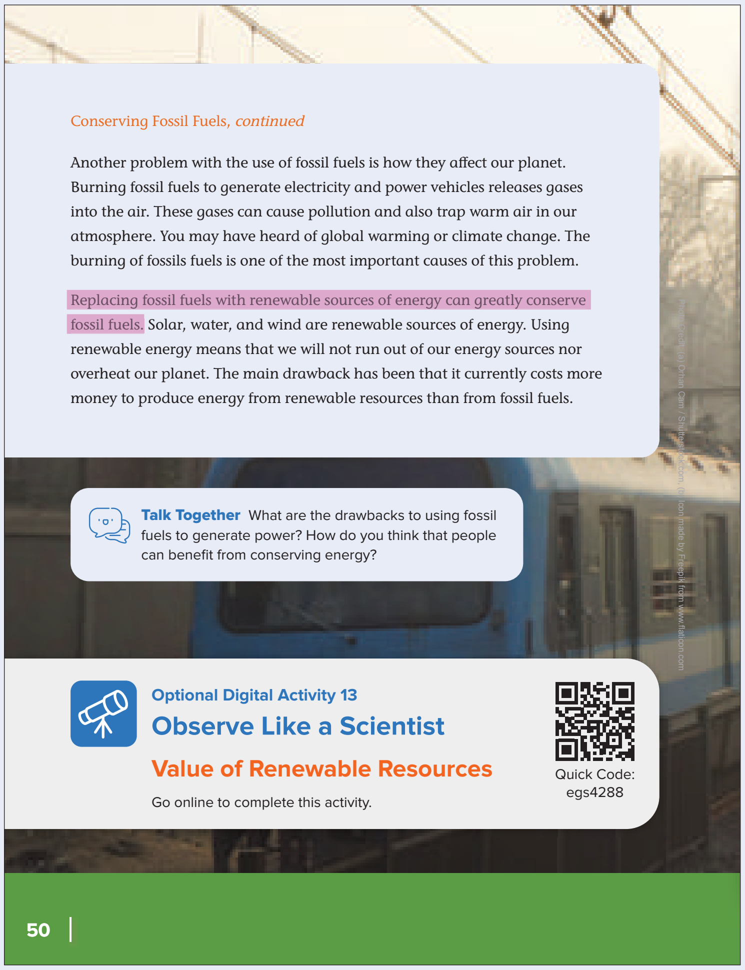

Conserving Fossil Fuels, continued

Another problem with the use of fossil fuels is how they affect our planet. Burning fossil fuels to generate electricity and power vehicles releases gases into the air. These gases can cause pollution and also trap warm air in our atmosphere. You may have heard of global warming or climate change. The burning of fossils fuels is one of the most important causes of this problem.

Replacing fossil fuels with renewable sources of energy can greatly conserve fossil fuels. Solar, water, and wind are renewable sources of energy. Using renewable energy means that we will not run out of our energy sources nor overheat our planet. The main drawback has been that it currently costs more money to produce energy from renewable resources than from fossil fuels.

Talk Together What are the drawbacks to using fossil fuels to generate power? How do you think that people can benefit from conserving energy?

Optional Digital Activity 13

Observe Like a Scientist

Value of Renewable Resources

Go online to complete this activity.

Quick Code: egs4288

50

Lesson 5, *continued*

Allow students to read the text about conserving resources and renewable resources independently or with a partner. To support emerging readers, review the meaning of vocabulary words as a class before reading the text.

Instruct students to underline the main idea of the passage and to highlight ways to conserve fossil fuels.

After students have had time to read the passage, lead a class discussion using the questions in the Talk Together box to begin the conversation.

Optional Digital Activity 13

Observe Like a Scientist

20 min

Value of Renewable Resources

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code: egst4288

Lesson 5, *continued*

Activity 14
Evaluate Like a Scientist

25 min

Using Fuels

Purpose

This formative assessment provides an opportunity to check for student understanding of the different types of fuel sources that have been introduced in this concept.

Instructional Focus

In this activity, students communicate their understanding of fuel sources as renewable or nonrenewable.

Strategy

The assessment item Using Fuels provides a formative assessment of students' understanding of renewable and nonrenewable resources. Instruct students to classify the fuels as renewable or nonrenewable.

When students have finished, provide them with the following additional energy resources: charcoal, ethanol, kerosene, and vegetable oil. Students may not be familiar with where these resources come from. Give students time consider how they might be classified and add them to their table.

Ask students to explain the reasoning behind their choices. Once students have had a chance to explain their thinking, discuss the origins of these resources with students. Allow students to make changes to their answers based on the new information.

Charcoal is made from wood. Ethanol is made from plant sugar, most often corn. Kerosene is a product made from crude oil. Vegetable oil is made from the seeds of plants.

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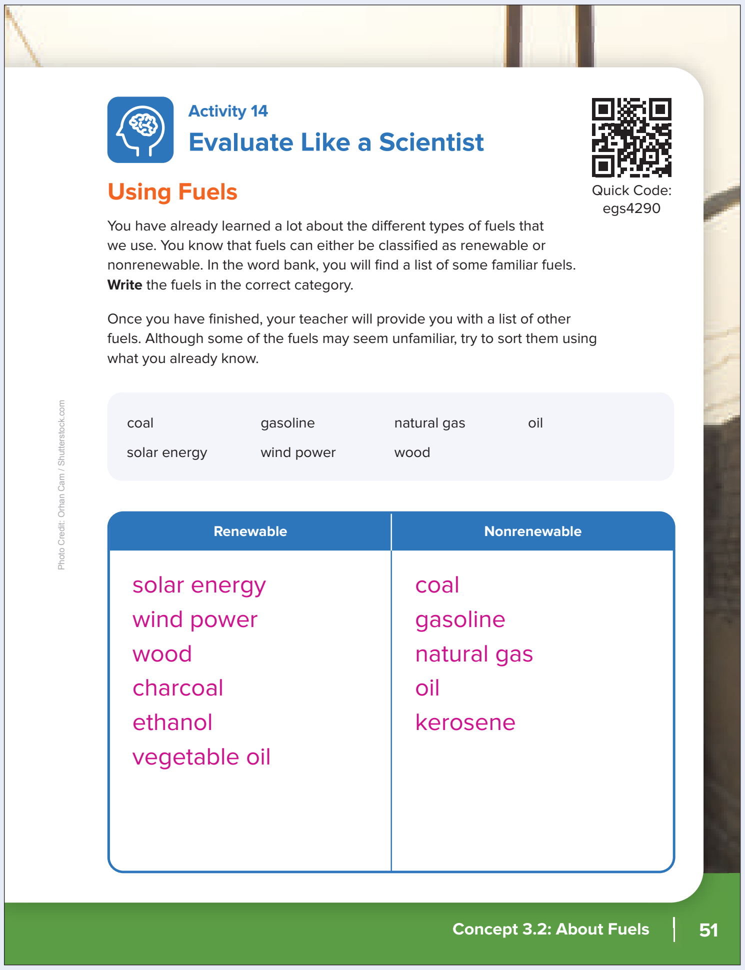
Activity 14
Evaluate Like a Scientist

Quick Code: egs4290

Using Fuels

You have already learned a lot about the different types of fuels that we use. You know that fuels can either be classified as renewable or nonrenewable. In the word bank, you will find a list of some familiar fuels. **Write** the fuels in the correct category.

Once you have finished, your teacher will provide you with a list of other fuels. Although some of the fuels may seem unfamiliar, try to sort them using what you already know.

coal, gasoline, natural gas, oil, solar energy, wind power, wood

Renewable	Nonrenewable
solar energy	coal
wind power	gasoline
wood	natural gas
charcoal	oil
ethanol	kerosene
vegetable oil	

Photo Credit: Orhan Cam / Shutterstock.com

Concept 3.2: About Fuels | 51

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Activity 14
Evaluate Like a Scientist
Using Fuels

Quick Code:
egst4290

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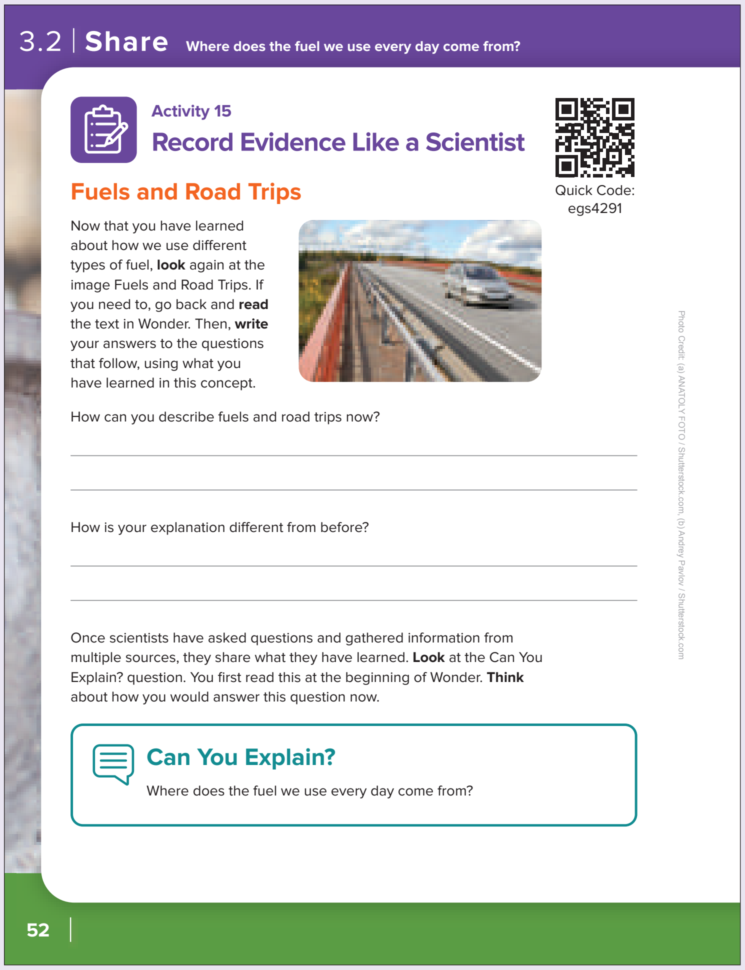
3.2 | Share Where does the fuel we use every day come from?

Activity 15
Record Evidence Like a Scientist

Quick Code: egs4291

Fuels and Road Trips

Now that you have learned about how we use different types of fuel, **look** again at the image Fuels and Road Trips. If you need to, go back and **read** the text in Wonder. Then, **write** your answers to the questions that follow, using what you have learned in this concept.

How can you describe fuels and road trips now?

How is your explanation different from before?

Once scientists have asked questions and gathered information from multiple sources, they share what they have learned. **Look** at the Can You Explain? question. You first read this at the beginning of Wonder. **Think** about how you would answer this question now.

Can You Explain?
Where does the fuel we use every day come from?

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Photo Credit: Andrey Pavlov / Shutterstock.com

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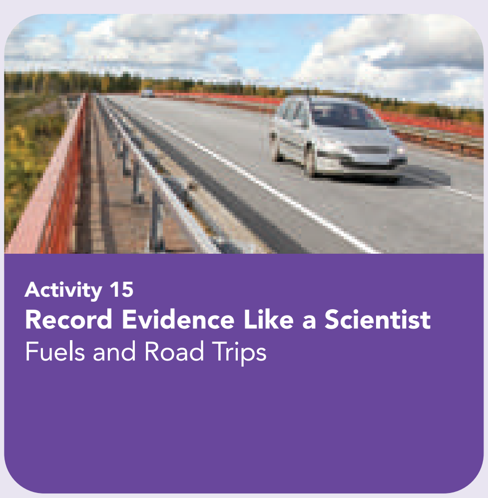

Quick Code:
egst4291

Lesson 6

Scientific Explanation

Activity 15
Record Evidence Like a Scientist

20 min

Fuels and Road Trips

Purpose

In this activity, students return to the question posed at the beginning of the concept and reconsider what they know now. The process of writing a scientific explanation using evidence to support a claim with reasoning is a key step in students constructing scientific knowledge that they can then use and apply.

Instructional Focus

In this activity, students return to their previous explanation of fuels and road trips to help them construct a scientific explanation in response to the Can You Explain? question.

Strategy

Display the investigative phenomenon of the Fuels and Road Trips photo and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the investigative phenomenon Fuels and Road Trips.

After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

Where does the fuel we use every day come from?

Lesson 6, *continued*

Students should be familiar with the claim, reasoning, and evidence framework. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, what can you conclude? It should not start with *yes* or *no*.

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that does not support the claim.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Provide students with the graphic organizer to generate their claim statements and record evidence to support their claims.

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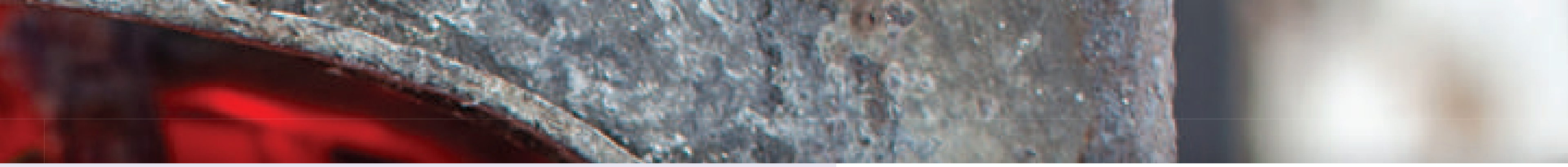
Now, use your new ideas about where fuel comes from to write a scientific explanation to answer this question. First, **write** your claim. Your claim is a one sentence answer to the Can You Explain? question. It should not start with a yes or no.

My claim:
Answers will vary.

Next, **record** the evidence that supports your claim. Then, **explain** your reasoning.

Evidence	Reasoning That Supports Claim
We learned that fossil fuels take thousands or millions of years to form. We are using up fossil fuels much faster than they can be replaced. We use fossil fuels in cars and to generate the electricity that powers many of our household appliances and devices.	Fossil fuels come from the remains of plants and animals that lived on Earth millions of years ago. These plants and animals became buried and changed slowly into fossil fuels. Coal, oil, and natural gas are fossil fuels. We spent time trying to live without electricity. We learned how much we depend on electricity and fossil fuels in our daily lives.



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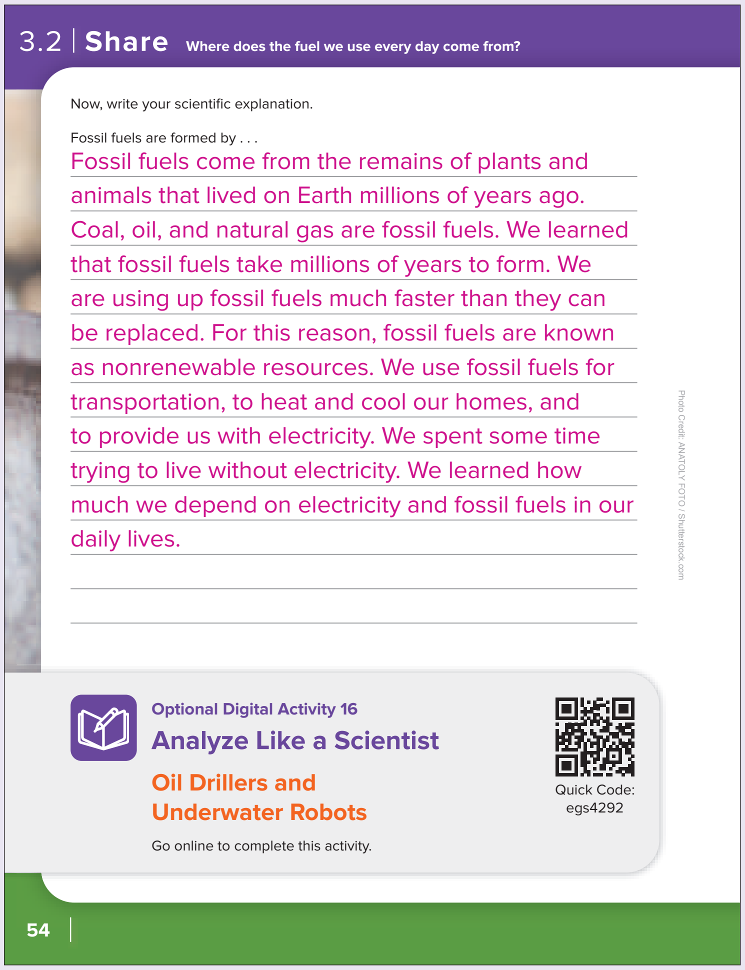

3.2 | **Share** **Where does the fuel we use every day come from?**

Now, write your scientific explanation.

Fossil fuels are formed by . . .

Fossil fuels come from the remains of plants and animals that lived on Earth millions of years ago. Coal, oil, and natural gas are fossil fuels. We learned that fossil fuels take millions of years to form. We are using up fossil fuels much faster than they can be replaced. For this reason, fossil fuels are known as nonrenewable resources. We use fossil fuels for transportation, to heat and cool our homes, and to provide us with electricity. We spent some time trying to live without electricity. We learned how much we depend on electricity and fossil fuels in our daily lives.

Optional Digital Activity 16

Analyze Like a Scientist

Oil Drillers and Underwater Robots

Go online to complete this activity.

Quick Code: egs4292

Photo Credit: ANATOLY FOTO / Shutterstock.com

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Lesson 6, *continued*

After providing scaffolding to the students, for those students able to do so, allow them to construct a full scientific explanation. They can write, draw, or orally describe their claim, evidence, and reasoning.

Sample student response:
Fossil fuels come from the remains of plants and animals that lived on Earth millions of years ago. Coal, oil, and natural gas are fossil fuels. We learned that fossil fuels take millions of years to form. We are using up fossil fuels much faster than they can be replaced. For this reason, fossil fuels are known as nonrenewable resources. We use fossil fuels for transportation, to heat and cool our homes, and to provide us with electricity. We spent some time trying to live without electricity. We learned how much we depend on electricity and fossil fuels in our daily lives.

Optional Digital Activity 16
Analyze Like a Scientist

20 min

Oil Drillers and Underwater Robots

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code: egst4292

Lesson 6, *continued*

Review and Assess

Activity 17
Evaluate Like a Scientist

25 min

Review: About Fuels

Purpose

The final activity of the concept asks students to review and explain the main ideas of the use of different types of fuels, where they come from, and how we use them.

Instructional Focus

Students first discuss and then summarize their learning in a written explanation about different types of fuels.

Life Skills **Self-Management**

Strategy

Now that students have achieved this concept's objectives, direct them to review the key ideas in their notes. Allow time for students to work with a partner or small group as they discuss their learning and any additional questions they have at this point. Once discussion has ended, direct students to explain in writing the characteristics, advantages, and disadvantages of different types of fuels and distinguish between renewable and nonrenewable energy sources.

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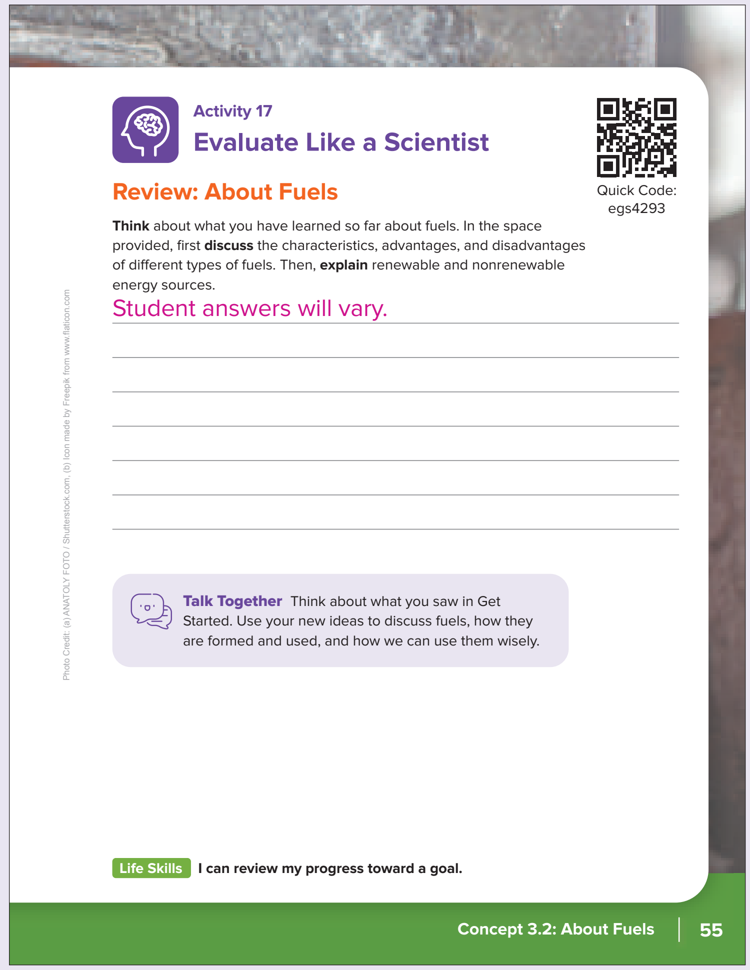

Activity 17

Evaluate Like a Scientist

Quick Code: egs4293

Review: About Fuels

Think about what you have learned so far about fuels. In the space provided, first **discuss** the characteristics, advantages, and disadvantages of different types of fuels. Then, **explain** renewable and nonrenewable energy sources.

Student answers will vary.

Talk Together Think about what you saw in Get Started. Use your new ideas to discuss fuels, how they are formed and used, and how we can use them wisely.

Life Skills I can review my progress toward a goal.

Photo Credit: (a) ANATOLY FOTO / Shutterstock.com, (b) Icon made by Freepik from www.flaticon.com

Concept 3.2: About Fuels | 55

DIGITAL

Activity 17
Evaluate Like a Scientist
Review: About Fuels

Quick Code:
egst4293

CONCEPT

3.3

Renewable Energy Resources

Photo Credit: Lovelyday12 / Shutterstock.com.

Concept Objectives

By the end of this concept, students should be able to:

- Apply scientific ideas to design, test, and refine devices that convert energy from one form to another.
- Construct explanations for the use of solar radiation, wind, and falling water in the generation of electricity.
- Develop models based on observations and evidence that energy is transferred from place to place by light, heat, and electricity.

Quick Code:
egst4294

Key Vocabulary

new: heat, light, radiation, solar energy, turbine, watermills, windmills

review: energy, energy source, generate, kinetic energy, renewable

Quick Code:
egst4295

Key Vocabulary Strategies

My Understanding

- As you introduce the vocabulary terms to students, have students create vocab cards for each term they come across. Each card should have the vocabulary term written in large capital letters in the center, with a definition in their own words above the term and a sentence (serious or silly) using the term in its correct context below the term. If students wish, they can include a quick sketch of what is going on in the sentence.
- After students complete their cards, have them share what they created with a partner.

Crossword Puzzle

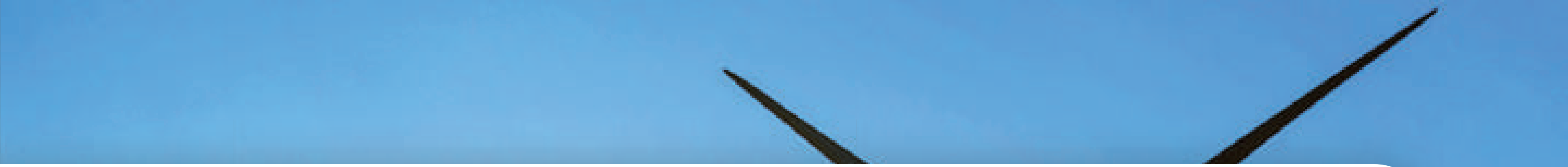
- After students have been introduced to the vocabulary terms, have them complete a crossword puzzle using either the definitions of each term or a sentence with the word missing. If needed, create a modified puzzle for students that uses definitions as the hints and has a word bank with the correct answers.
- The definition can be either pulled straight from the glossary or a definition written by the teacher.
- An example of a sentence with the word missing would be "Energy can be transferred by conduction, convection, or ___."

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Wonder	Lesson 1	Activity 1	10 min
		Activity 2	15 min
		Activity 3	20 min
Learn	Lesson 2	Activity 4	15 min
		Activity 5	15 min
		Activity 6	15 min
	Lesson 3	Activity 7	20 min
		Activity 9	25 min
	Lesson 4	Activity 10	45 min
Share	Lesson 5	Activity 11	45 min
Unit Project	Lesson 6	Complete Unit Project	90 min



Content Background

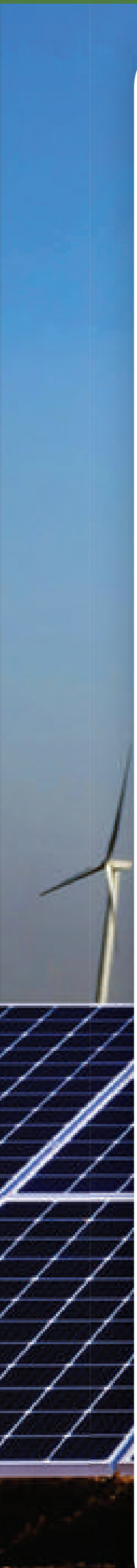
Students now have a fundamental understanding of how energy powers the devices in their lives. Students learned about how energy moves in and out of systems and which resources generate the majority of our electricity. Building upon a basic understanding of our current energy use, this concept gives students a look at the power resources of the future. Comprehending both the benefits and drawbacks of all types of energy use will be especially important for students as they work on their Unit Project at the end of the unit.

Powered by the Sun

The sun is crucial for life on Earth. It is the main source of energy for humans, plants, and animals. A vast majority of our energy on Earth comes from the sun, either indirectly by way of fossil fuels that are the ancient remnants of once-living organisms or directly through food and solar power. Scientists believe our sun is at least four billion years old, and it should keep producing enough heat and energy to sustain life on Earth for another 4 billion to 5 billion years. To this extent, the sun is a renewable resource.

Renewable Resources

Renewable resources are materials that people use for goods or energy that can be replaced as fast as or faster than they are used. Renewable resources include living things such as plants and animals, soil, water, wind, and sunlight. Nonrenewable resources, in contrast, are used faster than they can be replaced. Coal, oil, and gas, for example, take millions of years to form. Renewable energy resources are often referred to as "alternative energy sources" because they are an alternative to fossil fuels. Unlike fossil fuels, crops grow over the course of a year, and some types of trees can mature in just a few years. If plants and animals are used at a rate that is slower than they can be grown and raised, then the use of these living resources is sustainable. If humans use these resources faster than they can be replaced, however, then their use becomes harmful to the planet as well.



Content Background, *continued*

Effects of Using Resources

Renewable energy resources such as wind, running water, and sunlight are also considered to be "clean" resources. Converting running water, wind, and sunlight into electricity does not directly cause pollution because it does not involve burning anything. However, there are some environmental drawbacks to using renewable energy. Building hydroelectric plants involves damming up rivers. This floods river valleys and destroys habitats along the river. Wind turbines can kill birds and bats, and large wind farms may affect the microclimate of an area. Solar panels (like wind and water turbines) require mineral resources to build. Although plants and animals are renewable resources, using them can harm the environment if they are not managed properly. For example, clear-cutting a forest for lumber destroys habitats and causes erosion and pollution of water, as can farming and raising animals. Mining of materials can also destroy habitats and pollute soil and water.

Hands-On Investigations Preparation

Learn

Location	Instructional Focus	Materials to Prepare (per group)
Activity 10: Modeling a Turbine Generator	In this activity, students create a model of a turbine in a hydroelectric dam to show how the different substructures and materials function together to harness the flow of energy from water's movement.	• Large bin, at least 4L • Water • Pinwheel • Plastic cup, 250 mL • Large pitcher, at least 4L

Lesson 1

Activity 1
Can You Explain?

10 min

What are the different ways we can use renewable energy to generate electricity?

Purpose

This activity draws on students' prior knowledge and personal experiences by asking them to explain how renewable energy sources can be used to generate electricity.

Instructional Focus

In this activity, students focus on what they already know about renewable energy resources.

Life Skills **Endurance**

Strategy

Encourage students to explain what they know about how renewable energy resources can be used for electricity production. Challenge students to think about energy resources used in their area.

Students may have some initial ideas about how to answer the question. By the end of the concept, students should be able to construct a scientific explanation that includes evidence from the concept activities.

PRINT

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Activity 1

Can You Explain?

Solar panels are used to power the street lights on this city road.

What are the different ways we can use renewable energy to generate electricity?

We can generate electricity using several different renewable energy resources. Renewable energy means that it does not run out faster than we use it. Some types of renewable energy sources are wind, water, and solar energy.

Quick Code: egs4296

Life Skills I can share ideas I am not yet sure about.

Concept 3.3: Renewable Energy Resources | 57

Photo Credit: Good Luck Express / Shutterstock.com

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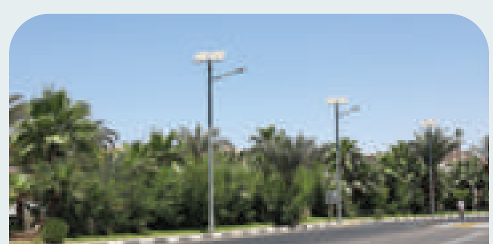
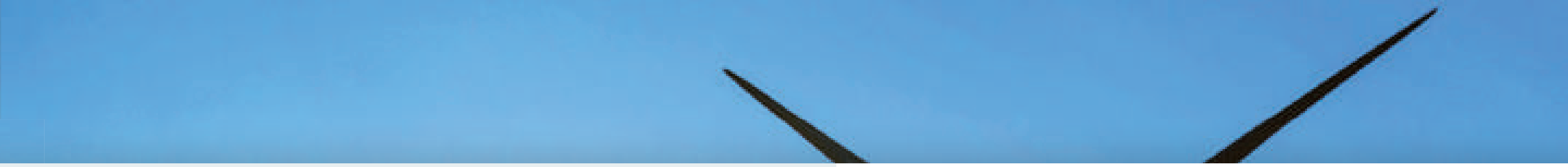


Activity 1
Can You Explain?

Quick Code:
egst4296



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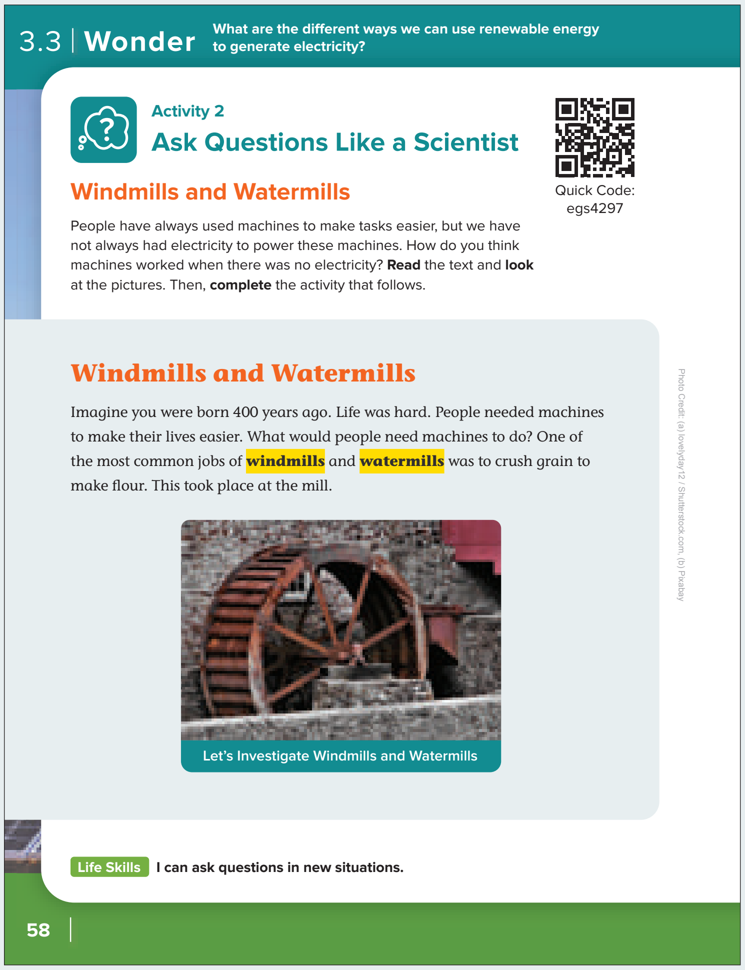

3.3 | Wonder What are the different ways we can use renewable energy to generate electricity?

Activity 2

Ask Questions Like a Scientist

Quick Code: egs4297

Windmills and Watermills

People have always used machines to make tasks easier, but we have not always had electricity to power these machines. How do you think machines worked when there was no electricity? **Read** the text and **look** at the pictures. Then, **complete** the activity that follows.

Windmills and Watermills

Imagine you were born 400 years ago. Life was hard. People needed machines to make their lives easier. What would people need machines to do? One of the most common jobs of **windmills** and **watermills** was to crush grain to make flour. This took place at the mill.

Let's Investigate Windmills and Watermills

Photo Credit: (a) lovelyday12 / Shutterstock.com; (b) Pixabay

Life Skills I can ask questions in new situations.

58

Photo Credit: Pixabay

DIGITAL

Activity 2

Ask Questions Like a Scientist

Windmills and Watermills

Quick Code: egst4297

Investigative Phenomenon

Activity 2
Ask Questions Like a Scientist

15 min

Windmills and Watermills

Purpose

The Investigative Phenomenon sparks curiosity in students as they begin to consider how devices from historical times compare to devices today that use renewable energy. Although many students may be familiar with windmills and watermills, students may not have a complete understanding of how they use energy to operate.

Instructional Focus

In this activity, students generate questions about devices that use renewable energy.

Life Skills **Endurance**

Strategy

Introduce this concept by asking students what types of machines existed in historical times. Encourage students to think about what life would have been like before the invention of modern engines and electrical devices.

Refer students to the first two images presented. Ask students if they recognize either machine. Accept all ideas, then tell students that each of these machines was once used to crush grain to make flour. Remind students that harnessing water for energy was described in the Anchor Phenomenon, Water for Energy, at the start of the unit. Identify the windmill and the watermill by name and talk about the historical significance to your area. Allow time for students to discuss with a partner or in small groups how each of these machines might have worked.

Lesson 1, *continued*

ASK

- *Which form of energy powered each of these devices? How?*
  Wind turned the blades of the windmill, which got the parts of the mill inside moving and allowed them to crush the grain. Moving water gave kinetic energy to the blades of the watermill, which then transferred this energy to the other parts of the mill in order to crush the grain.
- *What were the advantages and disadvantages of these forms of energy?*
  The advantages were that the cost of the energy was low and the energy was readily available. The disadvantages were that these methods were not as efficient as modern devices and were unreliable if the wind was not blowing or the water source dried up.
- *Do we use any of these forms of energy today? If so, how?*
  Student answers will vary based on prior knowledge. We do use wind turbines today that are similar to windmills, but they look much different and are used to generate electricity.

After discussing the images, instruct students to read the text, either independently or with a partner. Once finished, students should think of, write down, and share wonder statements and questions they would like to explore about the investigative phenomenon.

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Some mills used water, and other mills used wind. Can you think of some of the advantages these early mills had? What about disadvantages? Current wind and water turbines look both similar to and different from the windmills and watermills built hundreds of years ago. Why do you think they look different?


Windmill, mid-1800s


Modern Wind Turbines

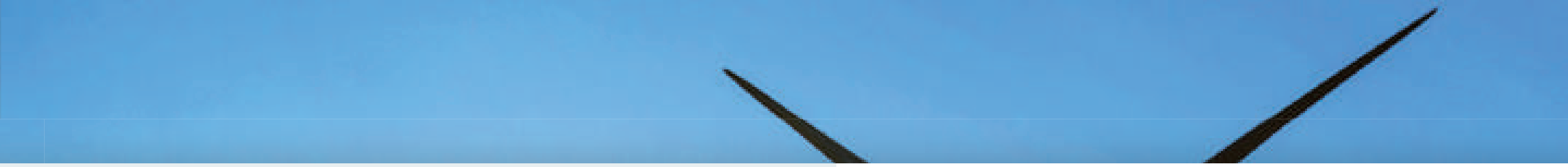
Photo Credit: (a) lovelyday12 / Shutterstock.com, (b) Raymond Albert / Shutterstock.com, (c) M_Photo / Shutterstock.com

Windmill and Watermill Energy

Write three wonder statements you have after observing the images of windmills and watermills.

Student answers may vary. I wonder why the older windmill has openings in the blades. I wonder why the newer wind turbine has fewer blades. I wonder why the newer wind turbines are taller than the older windmills.

Concept 3.3: Renewable Energy Resources | 59



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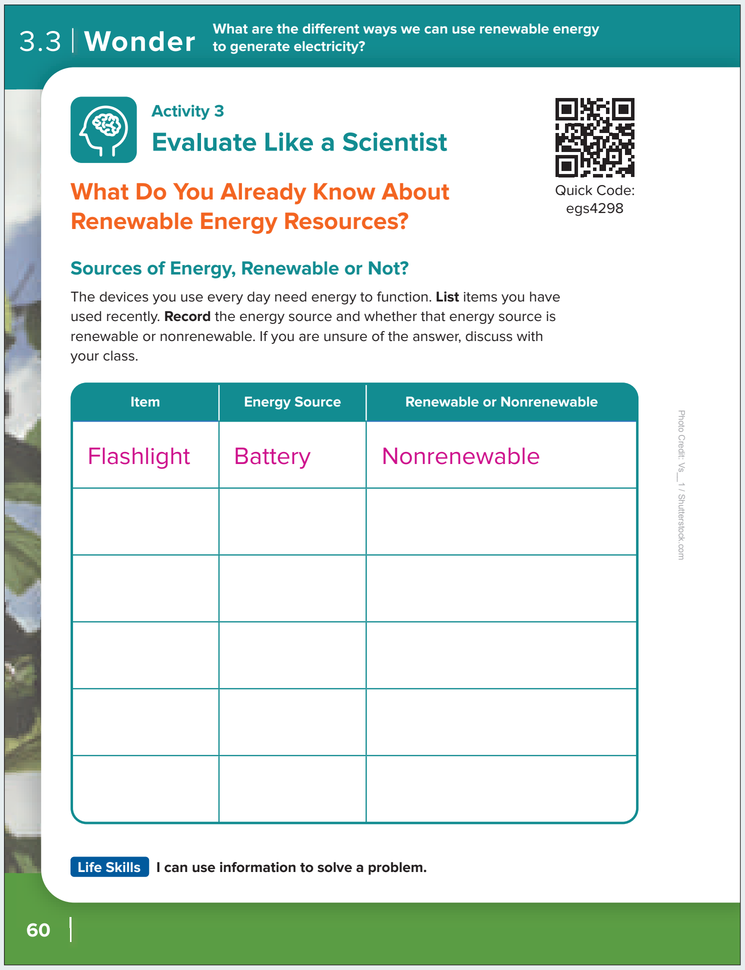

3.3 | **Wonder** What are the different ways we can use renewable energy to generate electricity?

Activity 3

Evaluate Like a Scientist

What Do You Already Know About Renewable Energy Resources?

Quick Code: egs4298

Sources of Energy, Renewable or Not?

The devices you use every day need energy to function. **List** items you have used recently. **Record** the energy source and whether that energy source is renewable or nonrenewable. If you are unsure of the answer, discuss with your class.

Item	Energy Source	Renewable or Nonrenewable
Flashlight	Battery	Nonrenewable

Life Skills I can use information to solve a problem.

60

DIGITAL

Activity 3

Evaluate Like a Scientist

What Do You Already Know About Renewable Energy Resources?

Quick Code: egst4298

Lesson 1, *continued*

Activate Prior Knowledge

Activity 3

Evaluate Like a Scientist

20 min

What Do You Already Know About Renewable Energy Resources?

Purpose

This formative assessment captures students' existing knowledge about the types of energy sources that are used in common devices. Students prepare for in-depth investigations into renewable energy sources.

Instructional Focus

In this activity, students activate prior knowledge of energy sources to determine whether a source of energy is renewable or nonrenewable.

Life Skills **Problem-Solving**

Sources of Energy, Renewable or Not?

Strategy

Present students with a battery-powered item that is easily available, such as a flashlight. Turn the flashlight on and off, and ask students where the flashlight gets the energy to light the bulb. Record the correct response on the board, beginning a list with three columns: item, energy source, and renewable or nonrenewable. Ask students for other examples of items that use some sort of energy, not necessarily a battery. Ideas may include a car engine, lamp, or windup toy. Record both the item and the energy source. Accept all answers, even those for which students may not know the energy source. This question is designed to probe existing knowledge of energy sources before beginning the activities in Learn.

Lesson 1, *continued*

Next, use two or three of the items from the list as examples. Ask students to identify whether the source is renewable or nonrenewable. Students may need to discuss among the class to make a determination. At this point, students will have limited knowledge. After future lessons, you may decide to return to the list and ask students to make any needed corrections.

Students will follow the same procedure to record five more items they used in the last day, their energy source, and whether the energy source is renewable or nonrenewable. At least three items on the list should be from students' own experiences.

Teacher Reflection

Based on my data:

- What content do my students already know?
- What misconceptions do my students have at this point in the course?
- Are any of my students ready for extension at this point in the lesson?

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Pages 61–62


3.3 | Learn What are the different ways we can use renewable energy to generate electricity?

What Are Some of the Different Ways We Use Energy from the Sun?

Activity 4

Observe Like a Scientist

Quick Code: egs4299

The Sun

You have studied the sun as a source of light and identified it at the beginning of energy chains. Have you ever wondered how the sun produces its light? **Read** the article and **think** about how the sun produces light and heat. Then be ready to discuss what you have learned.

The Sun

You have been trying to grow African violets in a pot. Although you remember to water them, they seem droopy. Your mother says, "I think they need more sunlight."

You find a sunny windowsill for your plant. You notice rays of light streaming through the window. It is definitely brighter here. It also feels warmer.

As you think about the sun, you start to realize how important it is. The sun gives us light and warmth. Plants need sunlight to grow. Without the sun, plants could not survive. Animals that eat plants couldn't survive either. Without the sun, life as we know it could not exist on Earth.

Concept 3.3: Renewable Energy Resources | 61

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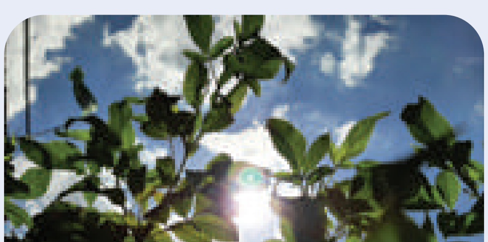


Activity 4

Observe Like a Scientist

The Sun

Quick Code: egst4299

Lesson 2

What Are Some of the Different Ways We Use Energy from the Sun?

Activity 4

Observe Like a Scientist

15 min

The Sun

Purpose

In order to consider how solar energy can be used to generate electricity, students first learn about the sun's basic composition and how it makes light and heat. This activity leads students into an exploration of solar energy.

Instructional Focus

In this activity, students read and discuss the sun's basic composition and how it makes light and heat.

Lesson 2, *continued*

Strategy

Begin by challenging students to brainstorm a list of ways we can use solar energy.

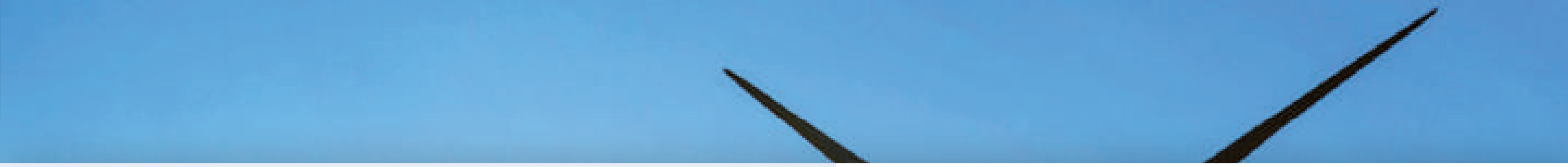
As individual students come up with suggestions, ask them to elaborate on their ideas. For example, students may mention solar panels but not understand that they are used to generate electricity.

Assign students to read the passage about the sun. Ask students to look for how the sun produces light and heat. Then lead a class discussion about what conditions are like inside the sun, as well as any questions that arise after reading the passage.

ASK

- *What is meant by the word* misconception*?*
  Student answers will vary. Something someone thinks that is not accurate.

- *What questions do you have after reading this text?*
  Student answers will vary.



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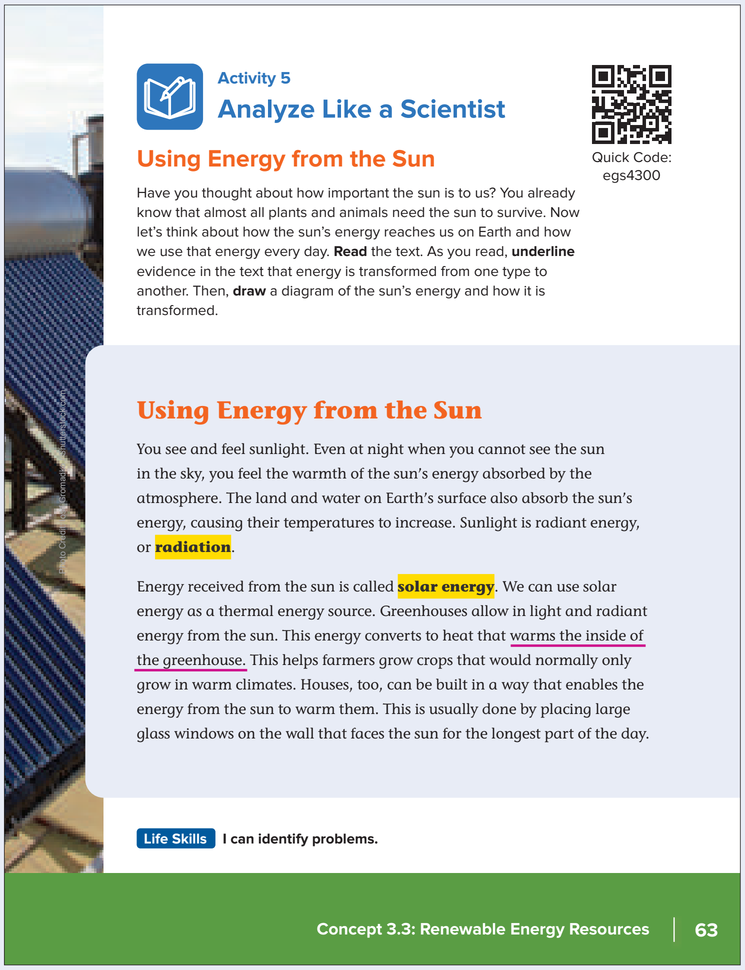

Activity 5

Analyze Like a Scientist

Using Energy from the Sun

Quick Code: egs4300

Have you thought about how important the sun is to us? You already know that almost all plants and animals need the sun to survive. Now let's think about how the sun's energy reaches us on Earth and how we use that energy every day. **Read** the text. As you read, **underline** evidence in the text that energy is transformed from one type to another. Then, **draw** a diagram of the sun's energy and how it is transformed.

Using Energy from the Sun

You see and feel sunlight. Even at night when you cannot see the sun in the sky, you feel the warmth of the sun's energy absorbed by the atmosphere. The land and water on Earth's surface also absorb the sun's energy, causing their temperatures to increase. Sunlight is radiant energy, or **radiation**.

Energy received from the sun is called **solar energy**. We can use solar energy as a thermal energy source. Greenhouses allow in light and radiant energy from the sun. This energy converts to heat that warms the inside of the greenhouse. This helps farmers grow crops that would normally only grow in warm climates. Houses, too, can be built in a way that enables the energy from the sun to warm them. This is usually done by placing large glass windows on the wall that faces the sun for the longest part of the day.

Life Skills I can identify problems.

Concept 3.3: Renewable Energy Resources | 63

Photo Credit: Iosif Gromadko / Shutterstock.com

DIGITAL

Activity 5

Analyze Like a Scientist

Using Energy from the Sun

Quick Code:
egst4300

Activity 5

Analyze Like a Scientist

15 min

Using Energy from the Sun

Purpose

Students use what they know about the sun to predict and then explain how solar energy can be transformed and used.

Instructional Focus

In this activity, students will summarize the information they read by creating a diagram that explains transfer of energy from the sun.

Life Skills **Critical Thinking**

Strategy

Direct students to read the text with a partner, taking turns to explain and discuss the text after each paragraph. Guide students to look for important points in the text that explain how we get and use energy from the sun. After discussion, ask students to underline evidence in the text that energy is transformed from one type to another. Next, direct students to work with their partner(s) to draw a diagram of the sun's energy and how energy is absorbed and reflected.

As a class, construct a main idea graphic organizer with all the ideas students have about how solar energy is converted into various types of energy.

ASK *How is solar energy converted into types of energy we can use?*

Student answers will vary but should indicate an understanding of the basic ideas outlined in the reading passage.

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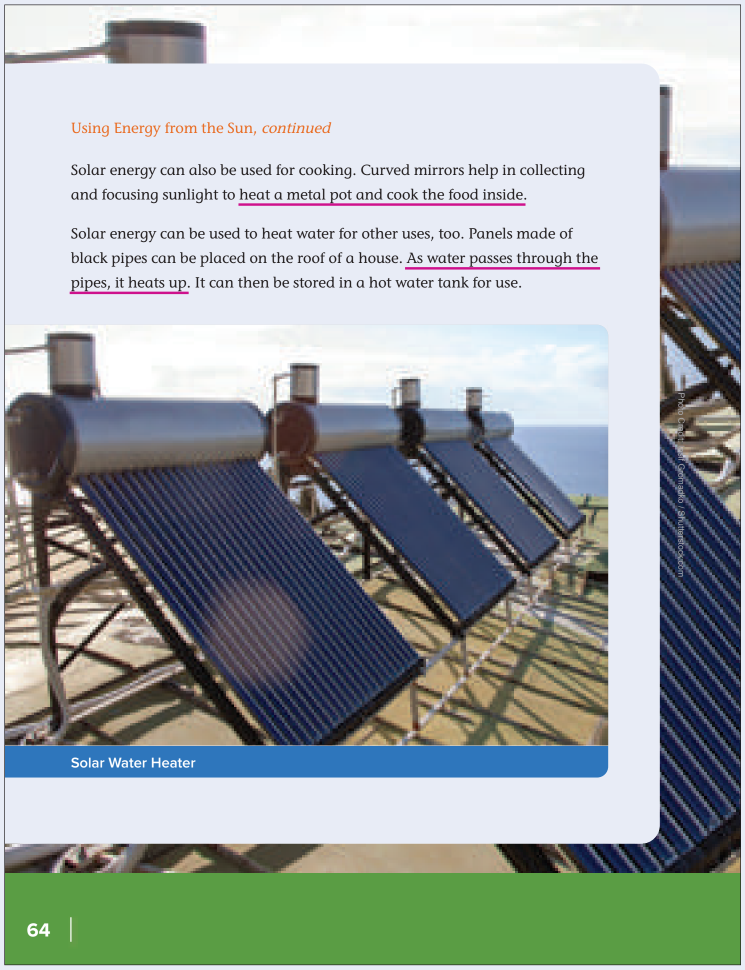

Using Energy from the Sun, *continued*

Solar energy can also be used for cooking. Curved mirrors help in collecting and focusing sunlight to heat a metal pot and cook the food inside.

Solar energy can be used to heat water for other uses, too. Panels made of black pipes can be placed on the roof of a house. As water passes through the pipes, it heats up. It can then be stored in a hot water tank for use.

Solar Water Heater

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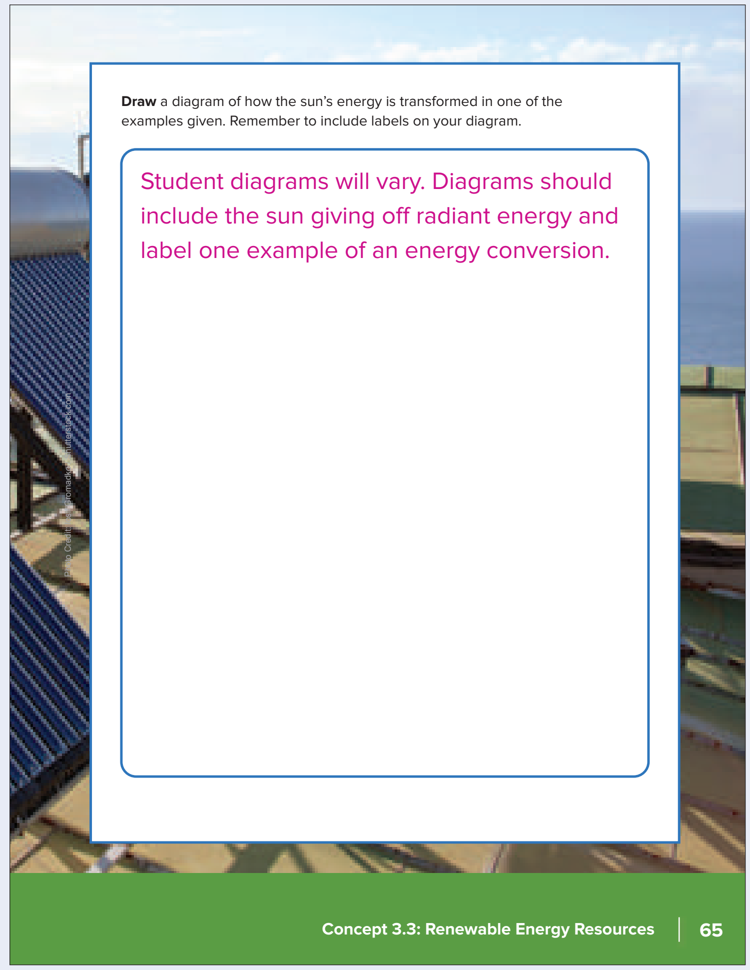
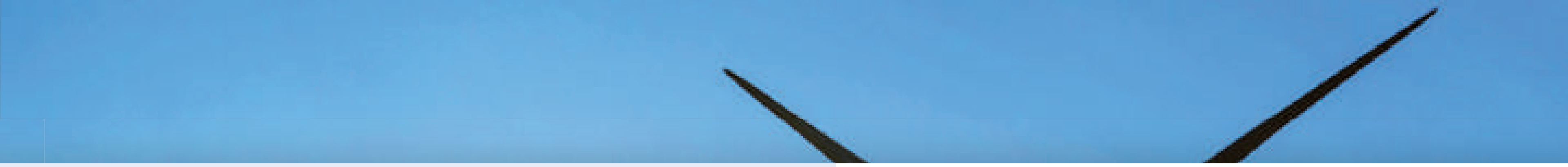


Draw a diagram of how the sun's energy is transformed in one of the examples given. Remember to include labels on your diagram.

Student diagrams will vary. Diagrams should include the sun giving off radiant energy and label one example of an energy conversion.

Concept 3.3: Renewable Energy Resources | 65



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3.3 | Learn What are the different ways we can use renewable energy to generate electricity?

Activity 6

Observe Like a Scientist

Solar Energy

Quick Code: egs4301

Have you seen solar panels in your community? Sometimes they are very small panels and supply energy to only one light. Other times they are very large or in sets that can supply energy to whole buildings or even towns. How might a farmer use solar panels? Look at the images. **Watch** the video and **read** the text. Then, **answer** the questions that follow.

Solar Panels

Solar-Powered Lights

Most solar panels are used to generate electricity. Solar panels that generate electricity are made of many small solar cells. These cells catch the radiant energy of the sun and turn it directly into electricity. This is called solar power.

Video

Life Skills I can identify problems.

66

Photo Credit: Alberto Masnovo / Shutterstock.com

DIGITAL

Activity 6

Observe Like a Scientist

Solar Energy

Quick Code: egst4301

Lesson 2, *continued*

Activity 6
Observe Like a Scientist

15 min

Solar Energy

Purpose

After learning about the source of and uses for solar energy, students consider how solar panels help transform the sun's energy into electricity.

Instructional Focus

In this activity, students use images, a video, and text to predict how solar panels might be used to collect energy from the sun.

Life Skills **Critical Thinking**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Present students with the images of solar panels. Students do not need to understand the details of how solar cells convert solar energy into electricity. However, the direct nature of the transformation should provide a contrast to the previous diagrams about how fossil fuels are used to heat water into steam, which turns a turbine, and so on. Ask students to recall the placement of the panels (for example: on a roof, atop a device, and so on). Allow time for students to make suggestions about how these energy systems or devices work.

Tell students that they are going to watch a short video showing how a farmer in Egypt uses solar energy. Ask students to focus on how the solar panels are beneficial to the farmer.

Lesson 2, *continued*

After students watch the video, encourage them to think about the following questions:

ASK

- *If the sun's energy is the input of the solar panel system, what is the output of the systems?*
  The output of the solar panel system is electricity.
- *Which form of energy enters the solar panels? Which form is the energy converted to?*
  Answers will vary. The solar panels capture the radiant energy from the sun and convert it to electrical energy or thermal energy.

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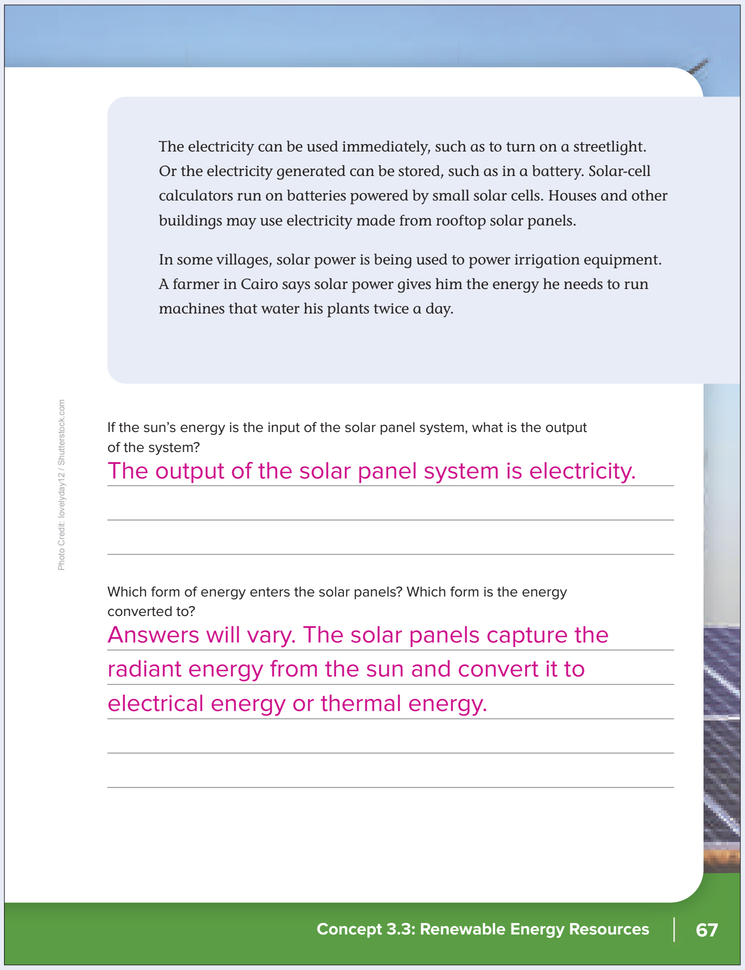


The electricity can be used immediately, such as to turn on a streetlight. Or the electricity generated can be stored, such as in a battery. Solar-cell calculators run on batteries powered by small solar cells. Houses and other buildings may use electricity made from rooftop solar panels.

In some villages, solar power is being used to power irrigation equipment. A farmer in Cairo says solar power gives him the energy he needs to run machines that water his plants twice a day.

Photo Credit: lovelyday12 / Shutterstock.com

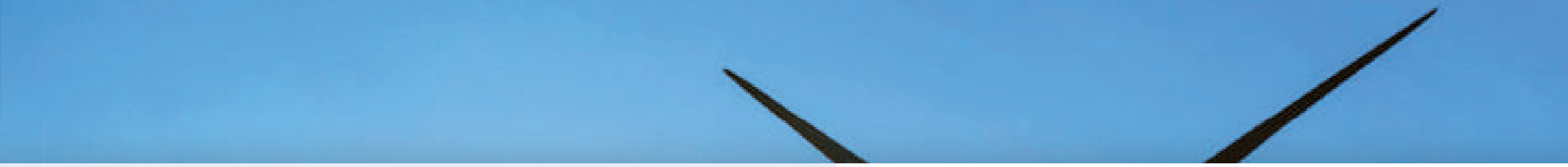
If the sun's energy is the input of the solar panel system, what is the output of the system?

The output of the solar panel system is electricity.

Which form of energy enters the solar panels? Which form is the energy converted to?

Answers will vary. The solar panels capture the radiant energy from the sun and convert it to electrical energy or thermal energy.

Concept 3.3: Renewable Energy Resources | 67



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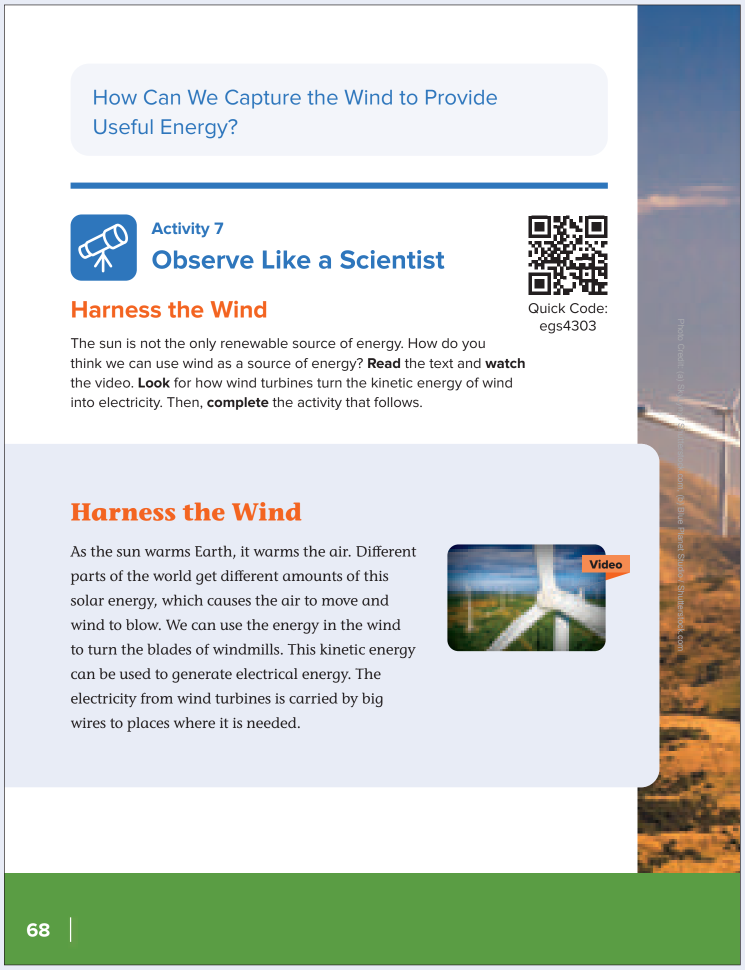

How Can We Capture the Wind to Provide Useful Energy?

Activity 7

Observe Like a Scientist

Quick Code: egs4303

Harness the Wind

The sun is not the only renewable source of energy. How do you think we can use wind as a source of energy? **Read** the text and **watch** the video. **Look** for how wind turbines turn the kinetic energy of wind into electricity. Then, **complete** the activity that follows.

Harness the Wind

As the sun warms Earth, it warms the air. Different parts of the world get different amounts of this solar energy, which causes the air to move and wind to blow. We can use the energy in the wind to turn the blades of windmills. This kinetic energy can be used to generate electrical energy. The electricity from wind turbines is carried by big wires to places where it is needed.

Video

68

Photo Credit: Blue Planet Studio / Shutterstock.com

DIGITAL

Quick Code:
egst4303

Lesson 3

How Can We Capture the Wind to Provide Useful Energy?

Activity 7

Observe Like a Scientist

20 min

Harness the Wind

Purpose

Students continue to explore renewable energy sources by considering how wind turbines turn the kinetic energy of wind into electricity. To demonstrate their knowledge, students create an energy chain of a turbine.

Instructional Focus

In this activity, students obtain information on the function of a wind turbine and apply the information to make a claim about an appropriate location to build a wind turbine.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Activate prior knowledge by asking students if they have ever seen a wind farm and if they know what wind farms are used for. Remind students of the reading from Wonder about windmills and watermills.

- Assign students to read the text on how wind is used to generate electricity.
- Instruct students to work in small groups to draw an energy chain showing the inputs and outputs of a wind turbine.

Lesson 3, *continued*

For students who need additional support, consider giving them the initial input or a sample output. For students needing significant support, consider giving them the parts of the chain to put in the correct order.

As the groups work, encourage them to think about the following questions.

ASK

- *What does a wind turbine do?*
  A wind turbine converts the kinetic energy of the wind to electrical energy.
- *How do scientists know where to place a wind turbine?*
  Scientists use models to predict the wind speeds at various locations.
- *What happens to the energy made by wind turbines?*
  The electrical current produced by a wind turbine is transported to a power generation station.

Differentiation

APPROACHING LEARNERS

If you have access to an ammeter, you can demonstrate how a generator works. Wrap some wire around a cardboard tube several times and attach both ends to an ammeter. Remove the cardboard tube and pass a bar magnet back and forth through the wire coil. The ammeter display will indicate an electric current when the magnet moves. Explain to students that, as a wind turbine turns, it rotates a coil of wire in a magnetic field, producing electricity.

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Draw an energy chain showing the inputs and outputs of a turbine on a wind farm.

Talk Together Now, talk together about the locations you think are best for wind turbines.

Optional Digital Activity 8

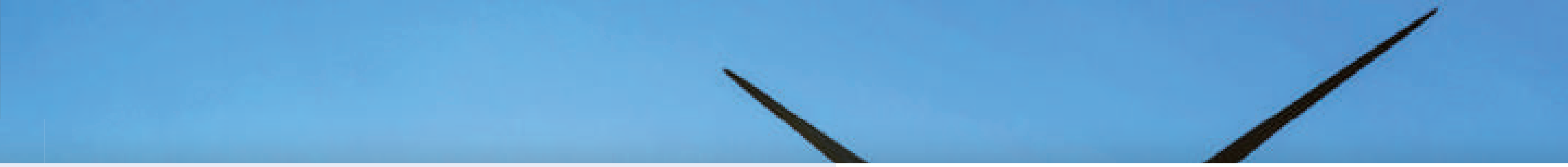
Investigate Like a Scientist

Hands-On Investigation: Building a Turbine

Go online to complete this activity.

Quick Code: egs4304

Concept 3.3: Renewable Energy Resources | 69



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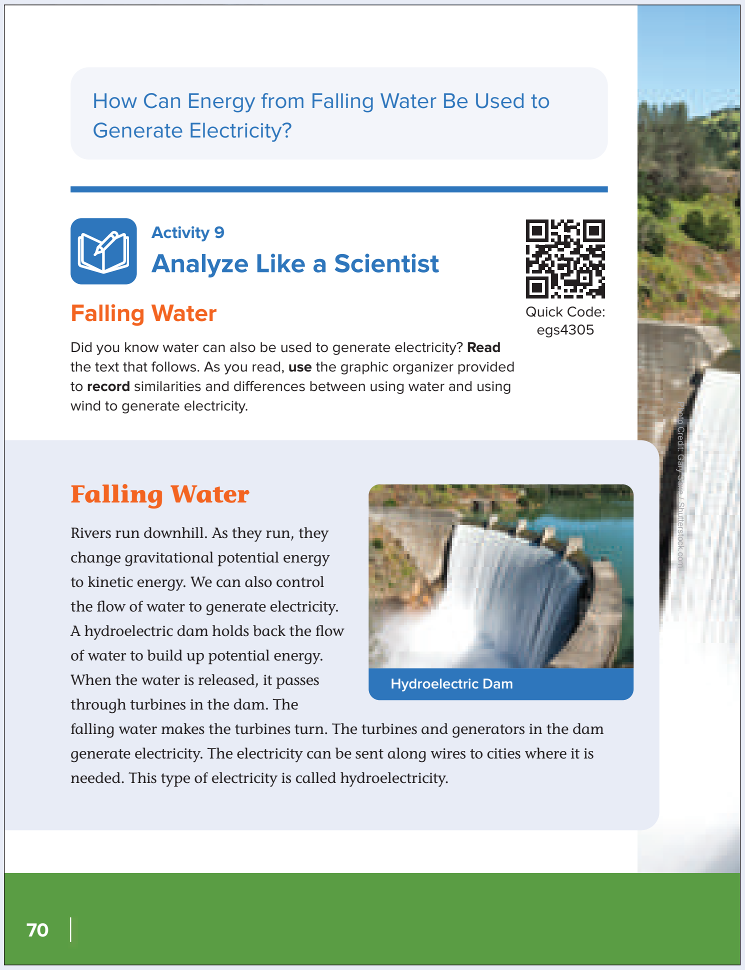

How Can Energy from Falling Water Be Used to Generate Electricity?

Activity 9

Analyze Like a Scientist

Quick Code: egs4305

Falling Water

Did you know water can also be used to generate electricity? **Read** the text that follows. As you read, **use** the graphic organizer provided to **record** similarities and differences between using water and using wind to generate electricity.

Falling Water

Rivers run downhill. As they run, they change gravitational potential energy to kinetic energy. We can also control the flow of water to generate electricity. A hydroelectric dam holds back the flow of water to build up potential energy. When the water is released, it passes through turbines in the dam. The falling water makes the turbines turn. The turbines and generators in the dam generate electricity. The electricity can be sent along wires to cities where it is needed. This type of electricity is called hydroelectricity.

Hydroelectric Dam

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Photo Credit: Gary Saxe / Shutterstock.com

DIGITAL

Activity 9

Analyze Like a Scientist

Falling Water

Quick Code: egst4305

Optional Digital Activity 8

Analyze Like a Scientist

25 min

Hands-On Investigation: Building a Turbine

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code: egst4304

How Can Energy from Falling Water Be Used to Generate Electricity?

Activity 9

Analyze Like a Scientist

25 min

Falling Water

Purpose

Students explore water as a third renewable source of energy and identify similarities and differences of systems that use water and wind to generate electricity.

Instructional Focus

In this activity, students gather information from a text and then use a graphic organizer to compare and contrast two systems.

Lesson 3, *continued*

Strategy

Begin by asking students to review the wind turbine as a system. Tell students they will be looking at another form of renewable energy: water. Guide students to think about what type of system could use water to create electricity. Falling water can be used to generate electricity. Direct students to read the text that explains how falling water can be used to generate electricity. Then, ask students to provide similarities and differences between using water and using wind to generate electricity.

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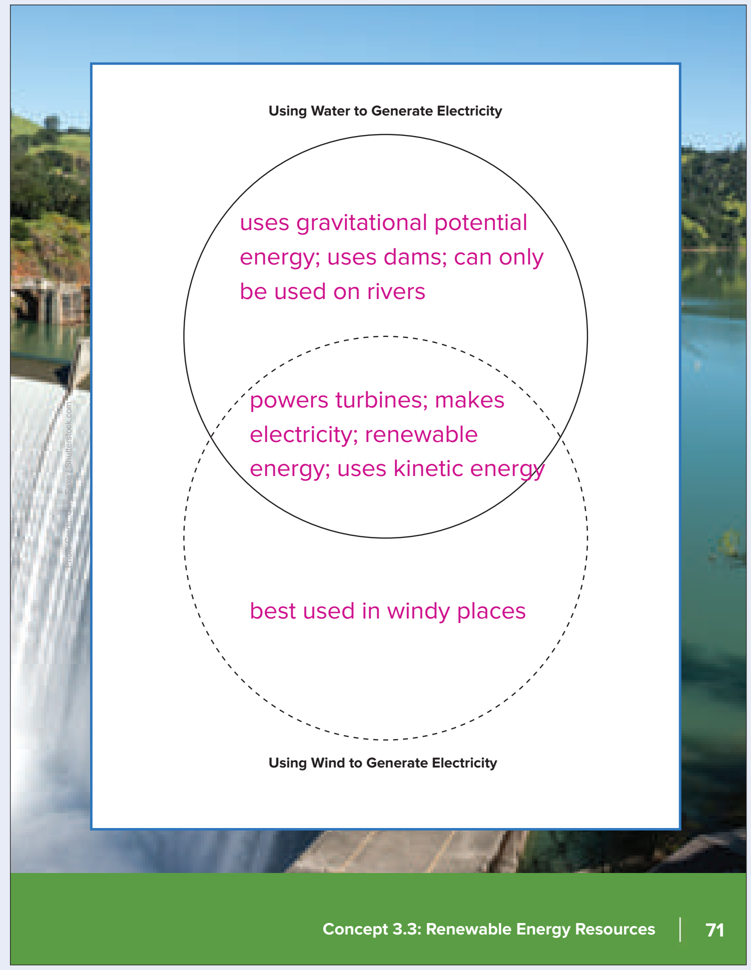

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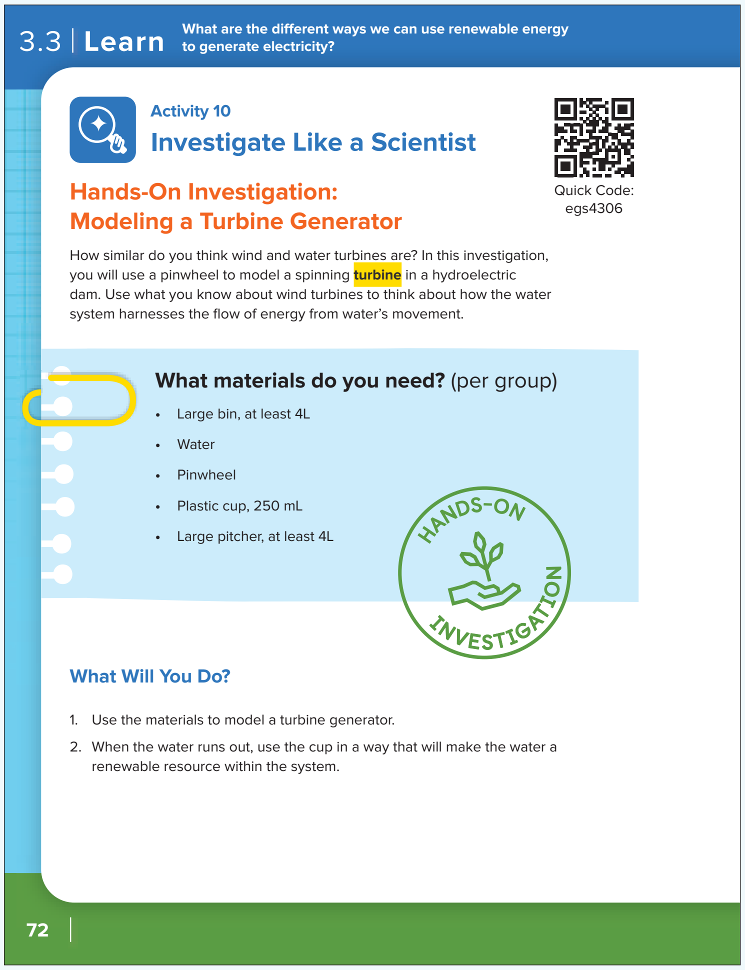
3.3 | Learn What are the different ways we can use renewable energy to generate electricity?

Activity 10

Investigate Like a Scientist

Quick Code: egs4306

Hands-On Investigation: Modeling a Turbine Generator

How similar do you think wind and water turbines are? In this investigation, you will use a pinwheel to model a spinning **turbine** in a hydroelectric dam. Use what you know about wind turbines to think about how the water system harnesses the flow of energy from water's movement.

What materials do you need? (per group)

- Large bin, at least 4L
- Water
- Pinwheel
- Plastic cup, 250 mL
- Large pitcher, at least 4L

HANDS-ON INVESTIGATION

What Will You Do?

1. Use the materials to model a turbine generator.
2. When the water runs out, use the cup in a way that will make the water a renewable resource within the system.

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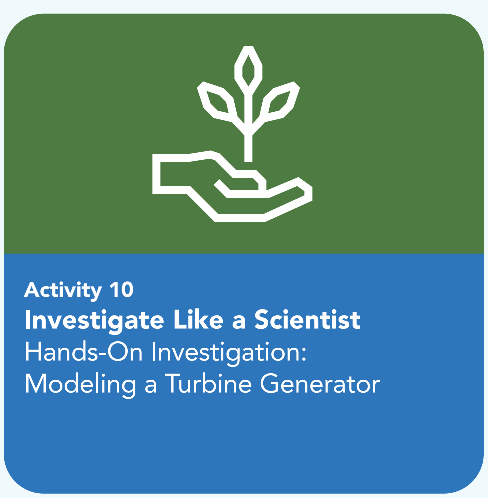

Quick Code:
egst4306

Lesson 4

Activity 10
Investigate Like a Scientist

45 min

Hands-On Investigation: Modeling a Turbine Generator

Purpose

Previously, students read about how electricity can be generated using flowing water. In this activity, students model a turbine in a hydroelectric dam to demonstrate how the turbine harnesses the flow of energy from water's movement.

Instructional Focus

In this activity, students create a model of a turbine in a hydroelectric dam to show how the different substructures and materials function together to harness the flow of energy from water's movement.

Lesson 4, *continued*

Activity Activator

For the Hands-On Investigation, students use a pinwheel to model a spinning turbine in a hydroelectric dam. No electricity is generated in this simple model. Remind students that in a real dam, the turbine turns a generator. Inside the generator, the kinetic energy of a spinning coil of wire in a magnetic field is converted to electrical energy.

You may choose to do this activity as a demonstration or have students complete it in small groups.

Display a pinwheel. Ask a student to blow on it so that it spins.

Materials List (per group)

- Large bin, at least 4L
- Water
- Pinwheel
- Plastic cup, 250 ml
- Large pitcher, at least 4L

HANDS-ON INVESTIGATION

Safety

- Follow all lab safety guidelines.
- Wear proper safety attire, including safety goggles.
- Tie back long hair.
- Do not eat or drink anything in the lab.
- Be especially careful of wet floors. Mop or wipe up wet floors to prevent injury from slipping or falling.
- The containers should not be made of glass for this activity.

Activity Procedure: What Will You Do?

Suggest that the pinwheel represents a turbine in a hydroelectric dam and ask students how they might get this pretend turbine to spin as one part of the process of generating electricity.

If you are going to do this as a demonstration, ask two students to help set up. Ask one student to hold the pinwheel above the large bin, while another student pours water onto it using the pitcher.

If you chose to have your students do this activity in groups, give them the materials and instructions and let them begin. Monitor the activity and assist as needed.

When the water runs out, the pinwheel will stop spinning. Ask students what this would imply if this were a real turbine involved in supplying electricity for people. Refer to the water in the container(s) as a resource that has been used to produce energy.

ASK *How would we describe the water that was originally in the pitcher? What could be done to keep the turbine (pinwheel) spinning?*
The water in the pitcher has potential energy. To keep the pinwheel spinning, we need to get the water in the bottom container back up to the pitcher.

Once the lower container begins to fill up in the demonstration or multiple groups' investigations, pause the investigation. Produce a cup and ask students how they could use the cup to replenish the supply and make the water a renewable resource within the system. Students should indicate that the water from the lower container could be scooped with the cup and poured back into the pitcher. Have a student volunteer do this. The student should continue this transfer for a while. Point out that you now have a system that can replenish itself and, as long as there is water in the pitcher, the turbine (pinwheel) will continue to spin and help produce electricity. In this case, the water could be considered a renewable resource.

Lesson 4, *continued*

Analysis and Conclusions: Think About the Activity

ASK

- *How did the pinwheel model part of a hydroelectric power station?*
  Students should describe or diagram their model.
- *Describe how you changed your model so it ran on renewable energy.*
  We transferred water from the lower container to the pitcher.

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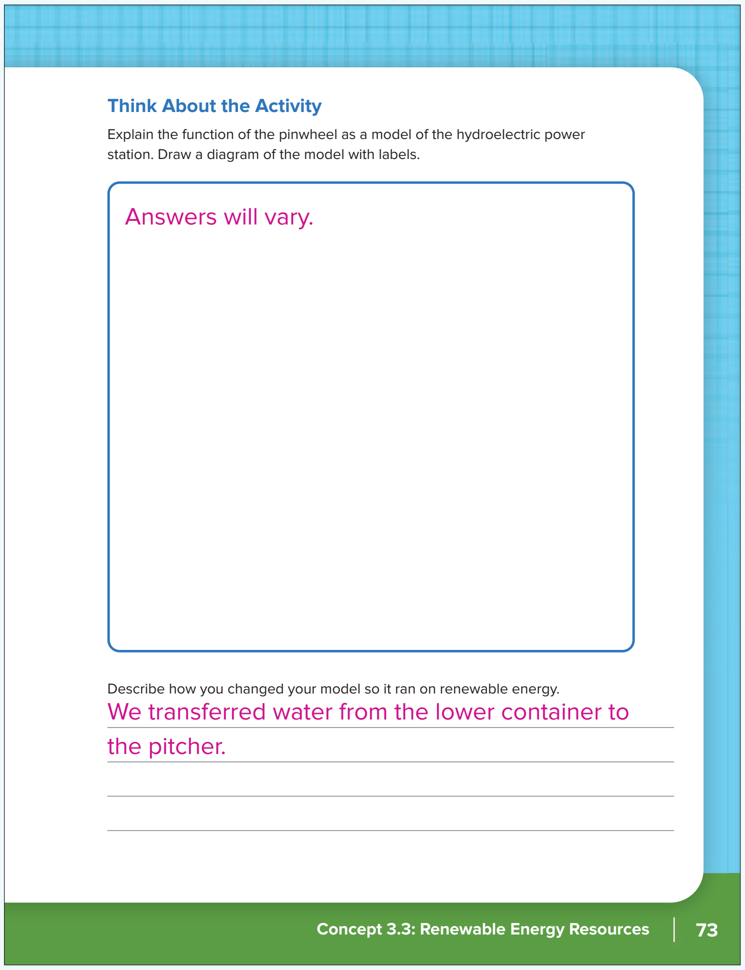

Think About the Activity

Explain the function of the pinwheel as a model of the hydroelectric power station. Draw a diagram of the model with labels.

Answers will vary.

Describe how you changed your model so it ran on renewable energy.

We transferred water from the lower container to the pitcher.

Concept 3.3: Renewable Energy Resources | 73

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3.3 | **Learn** **What are the different ways we can use renewable energy to generate electricity?**

How does your solution for providing a renewable resource mimic what happens on Earth? (Hint: consider the water cycle.)

The water in a river does not immediately flow back upstream to the pass through the hydroelectric dam again. Instead, the water flows into other bodies of water, is evaporated, and condenses as clouds, and rain or melting snow adds water back into the river.

Which alternative energy resources come from forms of mechanical energy?

Answer could include wind and water.

How can mechanical energy be used to generate electricity?

Answer should include mechanical energy being transformed into other forms of energy.

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Lesson 4, *continued*

ASK

- *How does your solution for providing a renewable resource mimic what happens on Earth? (Hint: consider the water cycle.)*
  The water in a river does not immediately flow back upstream to flow through the hydroelectric dam again. Instead, the water flows into other bodies of water, is evaporated, and condenses as clouds, and rain or melting snow adds water back into the river.
- *Which alternative energy resources come from forms of mechanical energy?*
  Answer could include wind and water.
- *How can mechanical energy be used to generate electricity?*
  Answer should include mechanical energy being transformed into other forms of energy.

Lesson 5

Scientific Explanation

Activity 11
Record Evidence Like a Scientist

45 min

Windmills and Watermills

Purpose
In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Instructional Focus
In this activity, students return to the investigative phenomenon and refine their scientific explanation and apply evidence collected throughout the concept to the Can You Explain? question.

Life Skills **Self-Management**

Strategy
Display the images from the investigative phenomenon and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon Windmills and Watermills.

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

What are the different ways we can use renewable energy to generate electricity?

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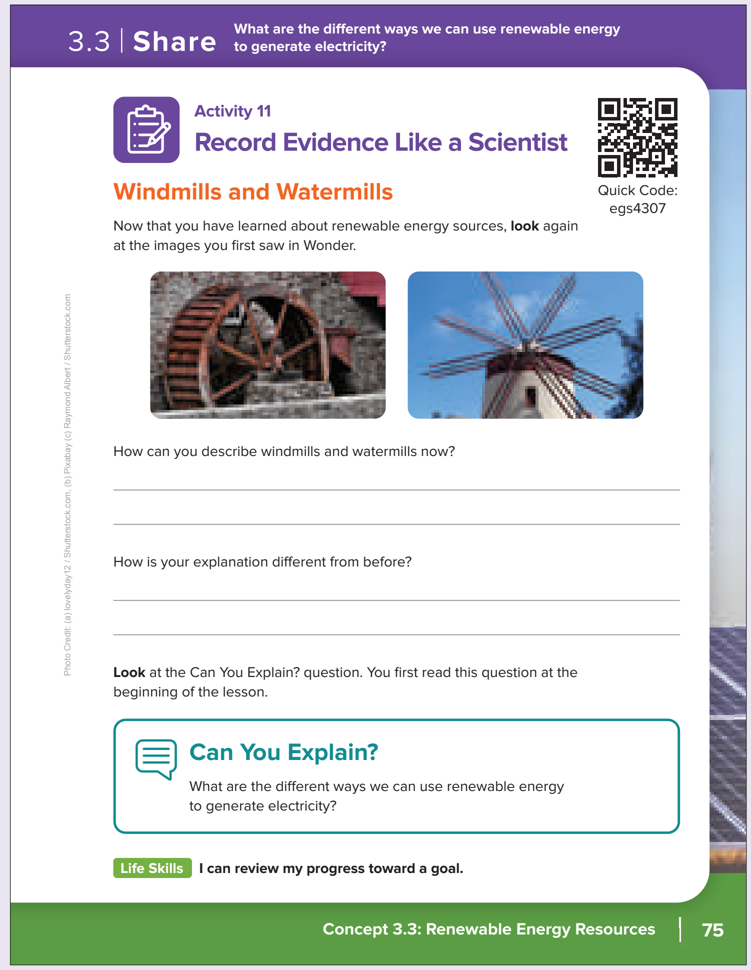
3.3 | Share What are the different ways we can use renewable energy to generate electricity?

Activity 11
Record Evidence Like a Scientist

Quick Code: egs4307

Windmills and Watermills

Now that you have learned about renewable energy sources, **look** again at the images you first saw in Wonder.

How can you describe windmills and watermills now?

How is your explanation different from before?

Look at the Can You Explain? question. You first read this question at the beginning of the lesson.

Can You Explain?
What are the different ways we can use renewable energy to generate electricity?

Life Skills **I can review my progress toward a goal.**

Photo Credit: (a) lovelyday12 / Shutterstock.com, (b) Pixabay (c) Raymond Albert / Shutterstock.com

Concept 3.3: Renewable Energy Resources | 75

Photo Credit: Pixabay

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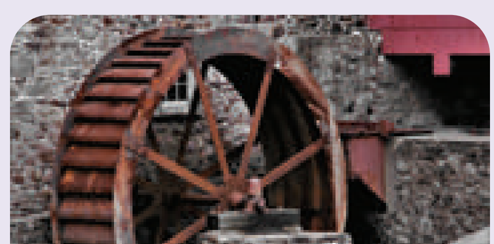
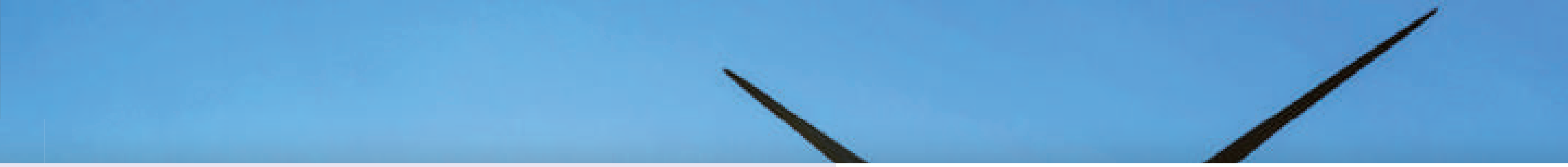


Activity 11
Record Evidence Like a Scientist
Windmills and Watermills

Quick Code:
egst4307



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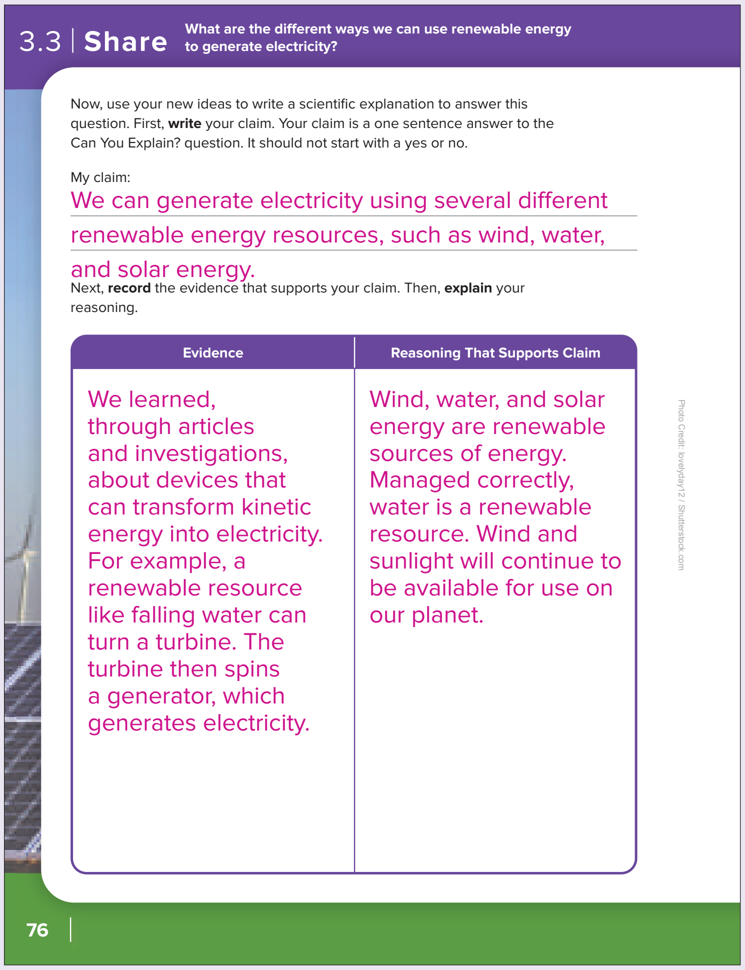

3.3 | **Share** What are the different ways we can use renewable energy to generate electricity?

Now, use your new ideas to write a scientific explanation to answer this question. First, **write** your claim. Your claim is a one sentence answer to the Can You Explain? question. It should not start with a yes or no.

My claim:

We can generate electricity using several different renewable energy resources, such as wind, water, and solar energy.

Next, **record** the evidence that supports your claim. Then, **explain** your reasoning.

Evidence	Reasoning That Supports Claim
We learned, through articles and investigations, about devices that can transform kinetic energy into electricity. For example, a renewable resource like falling water can turn a turbine. The turbine then spins a generator, which generates electricity.	Wind, water, and solar energy are renewable sources of energy. Managed correctly, water is a renewable resource. Wind and sunlight will continue to be available for use on our planet.

Photo Credit: lovelyday12 / Shutterstock.com

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Lesson 5, *continued*

Students should be familiar with the claim, evidence, and reasoning framework. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, what can you conclude? It should not start with yes or no.

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that does not support the claim.

Reasoning ties together the claim and the evidence and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to the claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Provide students with the graphic organizer to generate their claim statements and record evidence to support their claims.

Lesson 5, *continued*

After providing scaffolding to the students, for those students able to do so, allow them to construct a full scientific explanation. They can write, draw, or orally describe their claim, evidence, and reasoning.

Sample student response:
We can generate electricity using several different renewable energy resources. We read that a solar cell can produce electricity from light. Solar energy is a renewable energy source because it will not run out. Solar cells can be combined to produce solar panels, which can generate electricity to power various devices, cars, homes, and even airplanes. We learned from reading and videos that wind and water are also renewable energy sources that can be used to generate electricity. Wind turbines are devices that turn when the wind blows. A wind turbine is attached to a generator that can turn the kinetic energy of the moving turbine into electricity. We carried out an investigation in which we demonstrated that flowing water can also turn a turbine. Water is renewable because it is recycled in nature. Many large dams contain turbines, which are attached to generators. The water flowing over the turbines operates the generators, which produce electricity. This type of power is called hydroelectric power.

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Now, write your scientific explanation.
See sample student response in Teacher Materials.

Optional Digital Activity 12
Analyze Like a Scientist
Solar Power in Space
Go online to complete this activity.
Quick Code: egs4308

Optional Digital Activity 13
Evaluate Like a Scientist
Review: Renewable Energy Resources
Go online to complete this activity.
Quick Code: egs4309

Concept 3.3: Renewable Energy Resources | 77

Optional Digital Activity 12

Analyze Like a Scientist

20 min

Solar Power in Space

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code:
egst4308

Optional Digital Activity 13

Evaluate Like a Scientist

25 min

Review: Renewable Energy Resources

This optional activity can be found online. Optional digital activities can be used to extend student exploration or to challenge advanced students.

Quick Code:
egst4309

Unit Project

STEM

Solve Problems Like a Scientist

90 min

Dam Impacts

Purpose

Throughout Energy and Fuels, students have learned about the resources that fuel and power modern society. Students have explored the environmental implications of using both nonrenewable and renewable sources. In the Unit Project, students are asked to take a deep look at one source of renewable energy: water. Students will analyze both the benefits and drawbacks of constructing a dam for the purpose of generating electricity. This project provides students with an opportunity to synthesize what they have learned in a practical scenario. It also serves as a formative assessment of student understanding of the material covered in this unit.

Instructional Focus

The Unit Project allows students to return to the Anchor Phenomenon, Water for Energy, for the unit and apply objectives of the unit to solve or research a problem.

Life Skills **Decision-Making**

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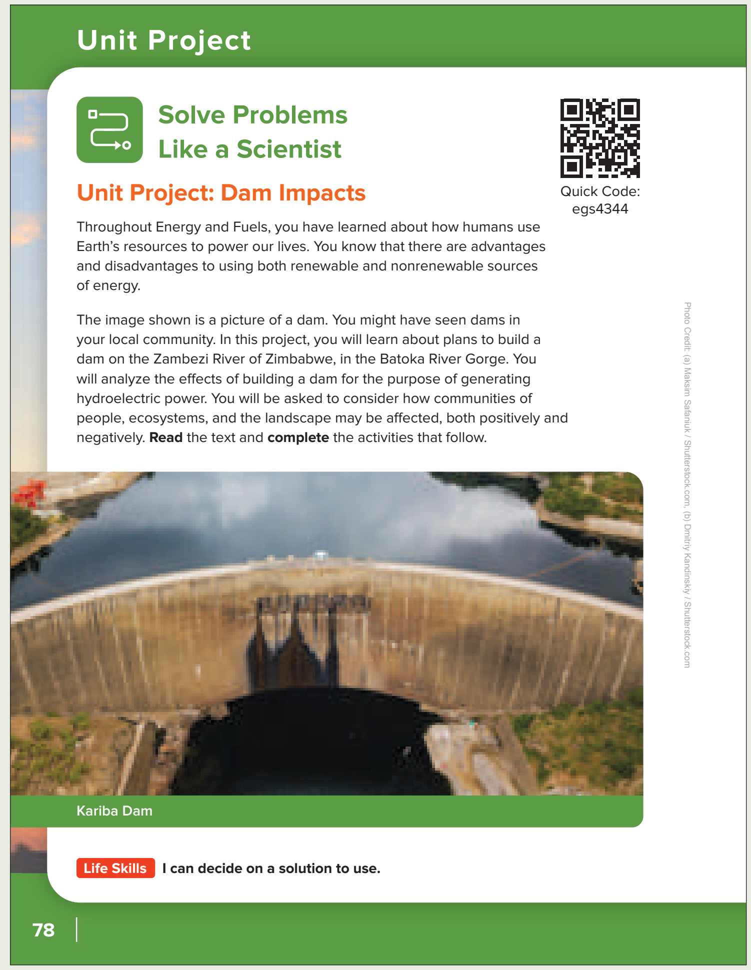
Pages 78–80



Unit Project

Solve Problems Like a Scientist

Quick Code: egs4344

Unit Project: Dam Impacts

Throughout Energy and Fuels, you have learned about how humans use Earth's resources to power our lives. You know that there are advantages and disadvantages to using both renewable and nonrenewable sources of energy.

The image shown is a picture of a dam. You might have seen dams in your local community. In this project, you will learn about plans to build a dam on the Zambezi River of Zimbabwe, in the Batoka River Gorge. You will analyze the effects of building a dam for the purpose of generating hydroelectric power. You will be asked to consider how communities of people, ecosystems, and the landscape may be affected, both positively and negatively. **Read** the text and **complete** the activities that follow.

Kariba Dam

Life Skills I can decide on a solution to use.

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DIGITAL

Quick Code:
egst4344

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In this project, you will investigate both the positive and negative impacts of building a dam.

You will be asked to consider both advantages and drawbacks, as well as conduct research to come up with solutions to the problems associated with hydroelectric power plants.

Positive or Negative?

Think about the potential impacts of building a dam in the Batoka River Gorge. Which of the following effects of creating a dam are positive, and which are negative? **Complete** the graphic organizer with the effects listed.

- changing fish migration routes
- flooding a habitat area of an endangered species
- producing hydroelectric power
- controlling the downstream river level
- providing a steady water supply

Positive	Negative
• controlling the downstream river level • producing hydroelectric power • providing a steady water supply	• changing fish migration routes • flooding a habitat area of an endangered species

Unit Project, *continued*

Strategy

This summative assessment provides students with the opportunity to analyze the effects of building a dam for the purpose of generating hydroelectric power. Students will assess the positive and negative impacts of a dam on the surrounding environment, including communities of people, ecosystems, and the landscape.

Students are asked to describe the positive and negative outcomes of building a dam to change the flow of a river; they are not asked to compare the positive and negative aspects of hydroelectric power to those of other sources of power (such as fossil fuels, wind, or nuclear). Such a comparison could serve as an extension activity to this project.

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Unit Project

Energy Transfer at the Batoka River Gorge Dam

Supporters of the proposed dam in the Batoka River Gorge claim that the hydroelectric power plant would produce thousands of hours of electrical power for people who do not currently have access. How would a hydroelectric power plant solve this problem? **Create** an energy model showing the energy transformations from water to electrical energy.

The energy chain should show the moving (kinetic) energy of the water being transferred to the mechanical energy (along with sound energy) of the turbine, and then to electric energy distributed by the power plant.

Photo Credit: Maksim Safaniuk / Shutterstock.com

Advantages and Disadvantages

In the next two sections, you will be asked to conduct research on the construction of dams. **Decide** what you think is the greatest benefit of building a dam for hydroelectric power. Then, **think** about the major drawbacks. Be sure to **list** all sources you use to research your answers.

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The Greatest Benefit

Choose the greatest benefit of building a hydroelectric power dam and **research** it. Then, **explain** why you chose that benefit as the best for communities of people, ecosystems, and the landscape surrounding a dam.

Student answers will vary but should accurately reflect the positive impacts of their chosen benefit on communities of people, ecosystems, and the landscape surrounding a dam.

Photo Credit: Maksim Safaniuk / Shutterstock.com

Disadvantages and Solutions

Choose one of the drawbacks of building a dam for hydroelectric power. Now, **research** possible solutions to that problem. **Write** a description of why it is important to address this problem, and then propose a solution.

Student answers will vary but should accurately reflect the negative impacts of their chosen drawback on communities of people, ecosystems, and the landscape surrounding a dam. The solution should be realistic and applicable to the chosen drawback.

Unit 3: Energy and Fuels | 83

Interdisciplinary Project

Solve Problems Like a Scientist

135 min

Interdisciplinary Project: Sunny Side Up

Instructional Focus

The Interdisciplinary Project challenges students to use science, literacy, math, and design skills to find a solution to a real-world problem. This project explores developing countries' need for inexpensive cooking fuel and the use of solar energy as a sustainable alternative to wood.

Life Skills Accountability

Life Skills Problem-Solving

Life Skills Decision Making

Project Overview

Each Interdisciplinary Project presents an opportunity for students to use the Engineering Design Process to design an original solution to the problem presented. A fictional story and a nonfiction article set up a challenge and provide students with necessary background information. A multistep hands-on investigation then leads students through the tasks of brainstorming and sketching designs, deciding on and planning a solution, then building a prototype. The project is best implemented over at least three lessons and could be extended to more depending on time available and student interest.

The project *Sunny Side Up* presents a challenge that is related to the United Nations Sustainable Development Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all.

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Interdisciplinary Project

Interdisciplinary Project: Sunny Side Up

Quick Code: egs4431

In this interdisciplinary project, you will use your science and math skills to find a solution to a real-world problem. First, you will read a story about a fictional group of characters, called the STEM Solution Seekers. Then, you will study some background information, and you will design, test, and refine a solution to the overall challenge. You will go through the steps of the Engineering Design Process, as shown in the diagram. You will also do some additional work in your math class related to this challenge.

The project *Sunny Side Up* challenges you to think about the impact of deforestation and how humans can use solar energy as a clean, renewable resource. In the story, you will read about a problem that a STEM Solution Seeker is having while trying to collect firewood to use as fuel for cooking. You will learn more about solar energy, and then you will design a solar cooker of your own to help find a solution.

Photo Credit: MS555 / Shutterstock.com

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Quick Code: egst4431

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Sunny Side Up

Jin, Claudia, Michael, and Hala are visiting Nadine, who lives in a village near Ngaoundere, Cameroon. They are all members of an international science fair team and usually work together over video calls. They are excited to be able to meet each other in person.

"Cameroon is so cool," says Michael as they walk along a dirt road in Nadine's village. "It is not like Washington, D.C., at all."

"It is much greener than Egypt," says Hala, "and there is no sea nearby."

As the five continue to walk toward Nadine's home, they begin to talk about their latest projects for the science fair. Claudia says, "Nadine, didn't you say you wanted help with some kind of a robot?"

"Well, yes," Nadine replies, "I want to create a robot to help me gather wood for my mom's cooking fire."

When they arrive at Nadine's home, they are welcomed warmly and almost immediately served a traditional meal of meat sauce, millet, and vegetables, which they enjoy while getting to know Nadine's family.

Unit 3: Energy and Fuels | 85

Interdisciplinary Project, *continued*

In this project, students learn about deforestation's harmful impacts on the rainforest and the use of solar energy as an alternative fuel for wood. Students analyze data in Cameroon and Peru to compare each country's loss of forest cover over time. In order to investigate solutions to combat deforestation, students then analyze a second set of data. Using information about hours of sunlight available in each country, students make calculations to investigate the practicality of using an alternate fuel source—solar energy. In the design challenge, students explore ways solar energy can be captured and converted to heat energy in a solar cooker.

Strategy

Prior to reading the text *Sunny Side Up*, allow students time to preview the images and make predictions on what they think the story will be about. If time allows, share that the story takes place in Ngaoundere, Cameroon, and locate the city on a map with students. Then, as a class, read the STEM Solution Seekers story.

Use the story to help students focus on the problem of deforestation, which is caused in part by the need for inexpensive fuel in developing countries. Students will consider the use of solar energy as a sustainable alternative to wood for cooking.

Encourage students to talk about and relate to the characters and situation in the story.

ASK

- *How is Nadine's life different from your experiences? How is Nadine's life similar to your experiences?*
- *What challenge do the characters encounter in the story?*
- *What are Nadine and Jin's different solutions to Nadine's problem?*
- *Have you seen solar panels before? Where were they and why were they being used?*

Interdisciplinary Project, *continued*

Tell students that in this project they will be helping the STEM Solution Seekers by creating a solar cooker that will use the heat from the sun's rays, instead of wood, to cook food.

To get started, divide students into groups of three or four. Groups will begin by reading the article on deforestation and solar energy to gather more information. Introduce students to the vocabulary word *deforestation* prior to reading. While students read the article, instruct them to highlight important information about the impact of deforestation and the use of solar energy as an alternative fuel.

Project Procedure

1. **Review the Challenge** Students read the challenge description, review the objectives, and study the requirements for their design.

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Interdisciplinary Project

Hands-On Investigation

Engineering Your Solution

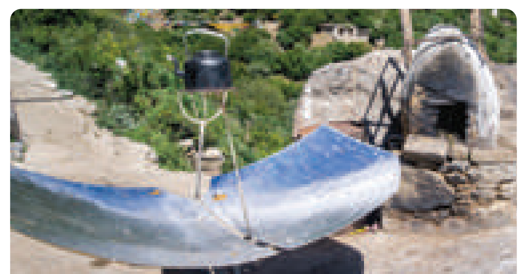
Challenge

You have been asked to create a solar cooker that can heat food to a safe temperature (71°C). This activity will guide your team through the Engineering Design Process.

Objectives

In this activity, you will . . .

- Review the challenge requirements and assign roles to each member of your team.
- Create three or four sketches to brainstorm solutions.
- Agree on one final blueprint for your prototype.
- Build a solar cooker that uses energy from the sun to cook food to a temperature of at least 71°C.



A Solar Cooker

Materials List (per group)

- Poster board or construction paper for final blueprint
- Building materials, such as a cardboard box, ruler, aluminum foil, plastic wrap, black paper
- Construction materials, such as tape, glue, scissors
- Testing materials, such as a thermometer, clock

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What materials do you need? (per group)

- Poster board or construction paper for final blueprint
- Building materials, such as a cardboard box, ruler, aluminum foil, plastic wrap, black paper
- Construction materials, such as tape, glue, scissors
- Testing materials, such as a thermometer, clock

HANDS-ON INVESTIGATION

Procedure

Follow these steps with your teammates:

1. **Review the Challenge** Study the challenge and design requirements for this project.
2. **Assign Group Roles** Decide the roles for the members of your group and record the names next to each role.
3. **Sketch Ideas** Review the materials data tables with your teammates and begin brainstorming. As a team, select three or four ideas to plan out in the Sketching Our Design boxes. Review your sketches and decide on one design to fully develop. Add more details to make it your blueprint that you will use to help you create your solution.
4. **Plan and Build** Gather materials and begin building your prototype. Make sure to keep track of your steps and process.
5. **Test** Once your prototype is finished, establish which materials you will need for testing. Discuss how you will measure the effectiveness of your design. Conduct your test according to your teacher's directions.
6. **Reflect and Present** When finished, review your product and your process. Identify ways you could improve. Prepare to share with your class.

Life Skills **I can review expectations.**

Unit 3: Energy and Fuels | 91

Interdisciplinary Project, *continued*

2. **Assign Group Roles** Review each group role as a class. Then, support groups as needed to discuss and choose roles for each member of the group. Have every student in the group record names in the Group Roles chart, so that groups can review the list at the beginning of each lesson. Remind students that every role is essential to the group's success.

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Interdisciplinary Project

Group Roles

Roles	Student name
Team Captain Provide encouragement and support; help other team members with their roles if needed; keep track of timeline	
Materials Manager Gather and organize materials; request additional materials if needed	
Chief Engineer Coordinate building the model; suggest when a test may be needed; make sure the team is building safely	
Team Reporter Record all steps of the process; share the process the team went through to complete the challenge	

Design Requirements

- ☐ Your solution must include a diagram and a prototype of your solar cooker, as well as a presentation sharing both your prototype (product) and how you worked together as a team (process).
- ☐ Your solution can only use materials your teacher has available and your design should be based on the data shared in the tables that follow.

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Testing Data

In order to maximize energy from the sun, consider the following three tasks of your solar cooker: How could you best **reflect** and direct the sunlight, **absorb** its heat, and **trap** that heat inside the solar cooker?

Review the following data tables to study how different materials affected the temperature that a cup of water can be heated to in the sunlight. Consider this information when choosing the materials and the design of your solar cooker.

Test 1: Reflecting Sunlight
The following test was applied to investigate the best material for the reflecting panels of a solar cooker.

	Aluminum Foil Panel	Red Construction Paper Panel	Cardboard Panel
Temperature of water after 20 minutes in sunlight	42°C	22°C	20°C

Test 2: Converting Sunlight
The following test was applied to determine the best way to convert sunlight to heat through absorption.

	Cup covered in black construction paper	Cup covered in light colored fabric	Clear cup
Temperature of water after 20 minutes in sunlight	40°C	35°C	30°C

Test 3: Trapping Sunlight
The following test was applied to determine the best way to trap heat inside of a cup of water.

	Clear cup	Cup covered in fabric	Cup covered in plastic wrap
Temperature of water after 20 minutes in sunlight	22°C	23°C	25°C

Unit 3: Energy and Fuels | 93

Interdisciplinary Project, *continued*

3. **Sketch Ideas** Students first review data tables that provide them with information about how different materials affect the reflection, absorption, and trapping of heat. Teams then brainstorm ideas for solutions in their groups. After some brainstorming, groups each select four ideas to plan out in the Sketching Our Design boxes. Each group member sketches at least one idea. Remind students that design sketches should include labels or notes and do not need to be artistic. Groups then review each member's sketches and decide on one design to fully develop. The questions provided beneath the sketching area support this discussion. To further support student groups in choosing a final design:

   ASK
   - *Does the design meet the requirements?*
   - *Can teams build a prototype of the design?*

Interdisciplinary Project, *continued*

Consider the following discussion protocol for classes that are new to this type of collaboration:

- Two students in the group discuss which design they would select based on the requirements and questions above.
- While the pair is discussing, the other two members of the group actively listen.
- The listening pair can also jot down any ideas that they want to remember. After several minutes, have the two pairs switch roles.

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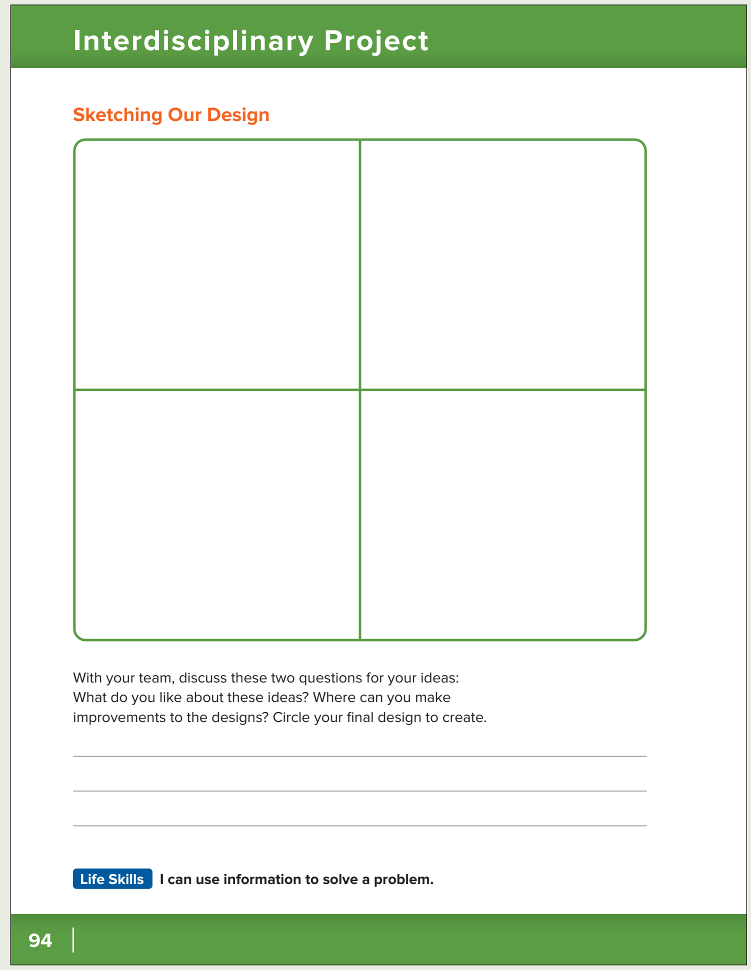

Interdisciplinary Project

Sketching Our Design

With your team, discuss these two questions for your ideas: What do you like about these ideas? Where can you make improvements to the designs? Circle your final design to create.

Life Skills I can use information to solve a problem.

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Plan, Build, and Test

STEP 1 Now that you have selected one design idea, create a separate diagram with additional details that you will share during your presentation. This detailed diagram is the blueprint for your prototype. Identify any materials that you will use on the detailed diagram. Show what your solar cooker will look like from the side view, the top view, and any other views you think are needed. Color code your team's blueprint to make sure you have the necessary working parts of a solar cooker with the following:

- In yellow, outline the part that directs the sunlight.
- In orange, outline the part that absorbs the sunlight.
- In red, outline the part that traps the heat.

STEP 2 Gather the materials you identified in your blueprint. You may need to make adjustments to these materials as you are building. Keep track of what you actually use.

STEP 3 Begin building your prototype. As you build, you may run into problems or challenges. Focus on one problem at a time and use your group's creativity and collaboration skills to find solutions. Engineers use notebooks and documentation to troubleshoot when things go wrong so that they can look for places to make improvements.

STEP 4 Test your solar cooker prototype. Leave the solar cooker outside on a sunny day for 30 minutes, or longer if necessary. Place a thermometer inside the solar cooker to measure the temperature inside. Make sure your solar cooker reaches a temperature of at least 71°C. Record the temperature and the time it took for your solar cooker to reach the temperature in your notes.

STEP 5 Once your prototype is complete, work with your team to create a presentation to share both your product and your process. Be sure to explain the parts of your prototype that direct, absorb, and trap sunlight. Also, prepare to share how your team worked together, if you encountered any problems, and how you worked to make improvements.

Life Skills **I can decide on a solution to use.**

Unit 3: Energy and Fuels | 95

Interdisciplinary Project, *continued*

4. **Plan, Build, and Test** The Plan, Build, and Test section of this project includes multiple steps:
    - Provide each group with a piece of paper or small poster board. Students begin by drawing a full diagram of the chosen solution with more details than the previous sketches. This diagram will be used as a blueprint, so remind students to label parts and materials to be used on the diagram. Students will use particular colors to outline the direction, absorption, and trapping of heat in their solution.
    - Review and display the materials that are available to construct prototypes. Adjust the items listed as needed based on the materials available. After reviewing and discussing materials in groups, the Materials Manager gathers materials and groups begin building a prototype. Remind students to keep track of the steps taken and building process.
    - Once students have built solar cookers, they should test their designs. Instruct students to leave the solar cooker outside on a sunny day for 30 minutes, or longer if necessary. Students should place a thermometer inside the solar cooker to measure the internal temperature. Solar cookers should reach a temperature of at least 71°C.

Interdisciplinary Project, *continued*

5. **Reflect and Present** When finished building, instruct groups to review the prototype and group process.

ASK
- *How could you improve your design?*
- *How could your group improve how you worked together?*

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Interdisciplinary Project

Advanced Learners: Writing Opportunity

Are you ready for a challenge? If time allows, write a set of directions for assembling your solar cooker and create an Assembly Instructions pamphlet. Add drawings with labels to clarify each step. Remember that your audience is people who have not used a solar cooker before and are accustomed to using wood as fuel.

Presentation Notes

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Analysis and Conclusions

Reflect on the following questions:

1. Did you and your group encounter any problems as you assembled and used your solar cooker? If so, how did you solve those problems?

2. Did your solar cooker perform as well as you expected? If not, what might explain this?

3. What improvements would you make to the design process or to your final prototype?

4. What was your role on the team? What did you do well? What improvements could you make?

Interdisciplinary Project, *continued*

Analysis and Conclusions

After a brief initial reflection, direct groups to discuss the Analysis and Conclusions questions. Each group member should record answers in their own words.

As time allows, have groups present their prototypes and reflections with the whole class or with one other group.

Primary 4 Resources

- Concept Assessments
- Graphic Organizers
- Safety in the Science Classroom
- Glossary

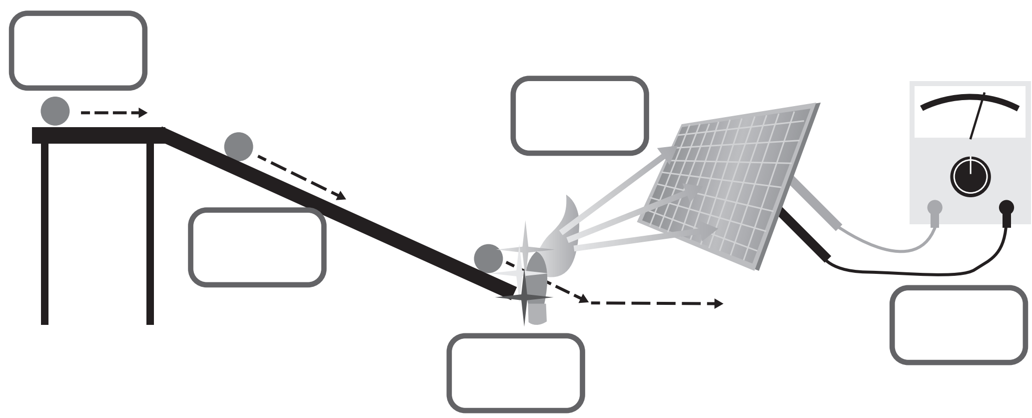
Concept Assessment
Unit 3, Concept 1: Devices and Energy

Name ______________________________ **Date** ________________

Instructions
Please answer each question carefully.

1. Rube Goldberg is well known for creating a series of cartoons showing complicated contraptions or machines. These contraptions usually do something simple that uses many different steps.

Here is a contraption that shows a ball on a table that rolls down a ramp. The ball strikes a match and the match ignites. The light from the match shines on a photo cell that creates electricity. The photo cell is connected to a meter that measures the voltage of the electricity.



Review the five forms of energy listed below. Identify the form of energy in this Rube Goldberg contraption by writing the corresponding letter in the correct spot.

- **A.** Light
- **B.** Chemical
- **C.** Mechanical
- **D.** Electrical
- **E.** Potential

Concept Assessment
Unit 3, Concept 1: Devices and Energy

Name ______________________ **Date** ______________

2. Your friend says the local hydroelectric plant creates electricity for your town. You know that this is not quite true because energy is not created or destroyed; it just changes from one form to another.

Read the description of the hydroelectric plant. Circle or highlight the sentences that will prove to your friend that energy is not being created, but that mechanical energy is being converted into electrical energy.

> Hydroelectric plants often have reservoirs of water built up behind a dam. This is why you often see a lake by a hydroelectric plant. The plant releases some of the water through a tunnel. The moving water spins the blades of a giant turbine. The turbine is connected to a generator, and the energy is changed into electricity for the town to use. The electricity flows through the wires to townspeople's homes.

3. Which statement correctly describes the energy of items in a home?

A. A computer uses electrical energy and nuclear energy.

B. An electric fan uses mechanical energy and sound energy.

C. An electric toaster uses radiant energy and chemical energy.

D. A clothes dryer uses nuclear energy and mechanical energy.

4. Energy is the ability to do work. Which of the following is considered energy?

A. air

B. car

C. water

D. electricity

Concept Assessment
Unit 3, Concept 1: Devices and Energy

Name ______________________________ **Date** __________________

5. In winter, some people turn on a gas fireplace to stay warm. Others use a generator or burn wood. Which, if any of these, are examples of using energy?

A. All are examples of using energy because work is done in each case.

B. None are examples of using energy because work is not done in any case.

C. Only using the generator is an example of using energy because the generator does work to make electricity.

D. Only using a gas fireplace and burning wood are examples of using energy because gas and wood are fuels.

6. Which definition of electricity is NOT correct?

A. Electricity is a form of energy that can do work.

B. Electricity is a form of energy that can make something move.

C. Electricity is a form of energy that flows from positive to negative.

D. Electricity is a form of energy found in the food we eat.

7. Which kind of energy is NOT produced by the sun?

A. heat energy

B. light energy

C. mechanical energy

Concept Assessment
Unit 3, Concept 2: About Fuels

Name ______________________ **Date** ______________

Instructions
Please answer each question carefully.

1. Ayman has just finished writing his report on fossil fuels. Read it over and help him find FOUR words or phrases that need to be revised because they give INCORRECT information. Circle or highlight the INCORRECT four words or phrases.

> You may not think about it, but you use energy every day. Each time you turn on a light, ride in an automobile, or use a computer or cell phone, you are using energy. Most of the energy comes from fossil fuels. Fossil fuels include coal, oil, and carbon monoxide. Using fossil fuels produces oxygen, which pollutes the environment. Instead of fossil fuels, try using nonrenewable resources, which never run out. For example, some people use solar energy, wind energy, or energy from oil. Other people just try to use fewer fossil fuels. For example, they ride a train or bus instead of driving or turn the lights off whenever they leave a room. If every person does just a little, we can help reduce pollution on Earth.

Concept Assessment
Unit 3, Concept 2: About Fuels

Name ______________________ **Date** ______________

2. Wagdy is very interested in helping people pollute less. Sometimes he can be bossy about it. Yesterday he was telling you what you had to do to help save the Earth. However, you were surprised because some of his rules did not make sense. Decide which rules are TRUE and will help reduce pollution and which rules are FALSE and will not reduce pollution. Insert a **T** (true) or **F** (false) in the column to the left to indicate with the rule will reduce pollution.

_______ Walk or ride your bike instead of driving.

_______ Drive your own car instead of sharing a car with your friend.

_______ Use coal instead of solar energy.

_______ Heat your house to a very warm temperature in the winter.

_______ Turn off your phone and computer when you are not using them.

_______ Do not leave the lights on in an empty room.

3. Fossil fuels form over millions of years. Put the steps in order to show how fossil fuels form. Order the statements in the column to the left with **1** as the statement that happened first and **5** as the statement that happened last.

_______ The plants and animals on Earth get old or sick and die.

_______ The remains of plants and animals decay and are covered by mud and sand.

_______ The ancient Earth is covered in swamp land where plants and animals thrive.

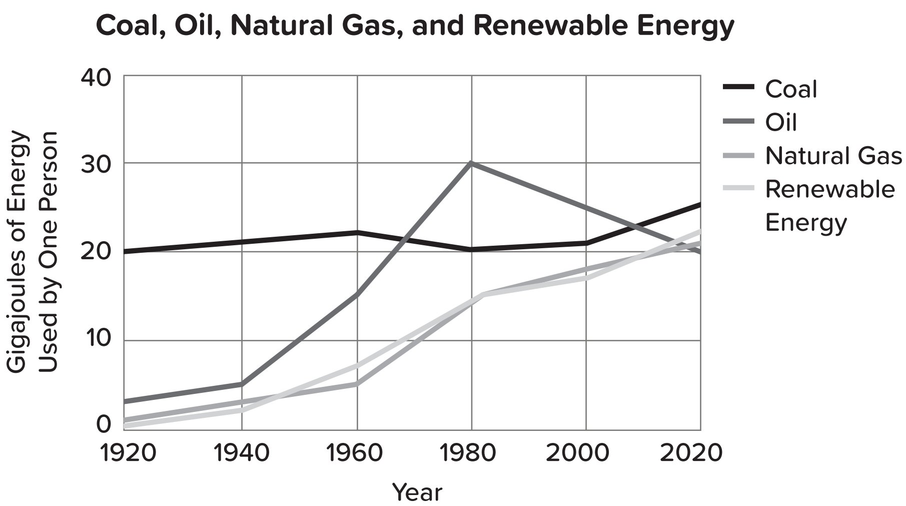
_______ Layers and layers of mud and sand build up over time.

_______ Heat and pressure from Earth turn plants into coal and animals into oil and gas.

Concept Assessment
Unit 3, Concept 2: About Fuels

Name ______________________________ **Date** ____________________

4. Hazem is looking at the graph below. It shows the average amount of energy one person has used over a period of 100 years. It also shows the various sources of the energy used. Study the graph and review the statements below. Circle or highlight the statements that are CORRECT.



In 1980, the amount of coal used was the same as the amount of oil used.

Oil was used the most in 1980 and has been used less and less ever since.

Coal has continuously been the most-used source of energy for the past 100 years.

By 2020, renewable energy will be the second most-used type of energy.

Coal usage has changed the least during the time period shown on the graph.

Concept Assessment
Unit 3, Concept 2: About Fuels

Name ______________________________ **Date** ____________________

5. You are an architect. Your friend wants to build a new house. She has a lot of ideas. Some ideas are for using renewable resources. Some ideas are for using nonrenewable resources. Read your friend's ideas. Help her decide which ideas use renewable resources and which ideas use nonrenewable resources. Write RENEWABLE or NONRENEWABLE in the column to the left to indicate what type of resource is mentioned in each statement.

______________________	I want to use geothermal heat to power my televisions and other electronic devices.
______________________	I want to use wood shipped from another country to build my house.
______________________	I want to use oil to heat my home in the winter and cool it in the summer.
______________________	I want to use wind turbines to provide power for large electrical appliances like my refrigerator.
______________________	I want to use solar energy to heat the water for laundry and bathing.
______________________	I want to use natural gas to provide electricity for lights in my home.

6. How is oil different than hydroelectric power?

- **A.** Oil can be replaced while hydroelectric power is limited.
- **B.** Oil is considered a renewable resource; hydroelectric power is not.
- **C.** Oil is renewable but hydroelectric power is nonrenewable.
- **D.** Oil resources are limited but hydroelectric resources are practically unlimited.

Concept Assessment
Unit 3, Concept 2: About Fuels

Name ______________________ **Date** ______________

7. The local government has decided to take actions to reduce the area's dependence on fossil fuels. Which of the following actions might help reach the goal?

- **A.** Provide grants for people to install solar panels on their homes.
- **B.** Build a new coal-fired power plant to increase electricity production.
- **C.** Convert coal-fired generators to use natural gas.
- **D.** Convert city-owned vehicles from gasoline to natural gas.

8. What advantage do wind and solar have over coal and oil?

- **A.** Wind and solar are not renewable; coal and oil are.
- **B.** Wind and solar are easier to use.
- **C.** Wind and solar are renewable; coal and oil are not.
- **D.** Wind and solar produce byproducts; coal and oil do not.

9. Which of the following pairs of materials are good natural resources for providing energy?

- **A.** gravel and oil
- **B.** trees and carbon dioxide
- **C.** the ocean and soil
- **D.** wind and natural gas

Concept Assessment
Unit 4, Concept 1: Breaking Down and Moving Rocks

Name ______________________________ **Date** ____________________

Instructions
Please answer each question carefully.

1. Fast moving water erodes part of the riverbank. When the river slows down, some of the sediment is left in a new place. What is this process of leaving material in a new location called?

- **A.** Deposition
- **B.** Erosion
- **C.** Sediment
- **D.** Conservation

2. When elements of weather, such as wind or water, wear away the surface of a rock, which process is taking place?

- **A.** weathering
- **B.** melting
- **C.** heat and pressure
- **D.** volcanic activity

3. Circle or highlight the five words in the paragraph that could also be used to describe the term “erosion.”

As a rock moves from place to place throughout Earth, it can undergo several processes that can change its appearance or chemical makeup. At the surface, different elements like wind or rain may break down and relocate the rock fragments to new locations. Rocks may be transferred to a low-lying area. Over time, layers of sediment build up on top of each other and can solidify to become sedimentary rock. It can even possibly shift them to deeper layers of the earth where they encounter a whole new set of geological processes.

Concept Assessment
Unit 4, Concept 1: Breaking Down and Moving Rocks

Name ______________________________ **Date** ____________________

4. Landslides are formed by different geological processes. Draw a line to match each step of landslide formation to the geological process that causes it.

Geological Processes	**Steps of Landslide Formation**
A. Erosion	**1.** Step 1: Large boulders and rocks are broken down over time and mixed with decayed plant matter.
B. Deposition	**2.** Step 2: Bits of soil mixes with water and is washed downhill.
C. Weathering	**3.** Step 3: Rock, dirt, and mud solidify at the bottom of the mountain.

5. Which of the following is classified as chemical weathering?

A. ice breaking rocks

B. elements in the water mixing with rocks, causing a reaction that dissolves parts of the rock

C. tree roots growing into rocks

D. rocks bumping into each other in a fast-moving stream

6. What is the process of moving broken earth materials to a different location?

A. erosion

B. sanding

C. weathering

D. deformation

Concept Assessment
Unit 4, Concept 1: Breaking Down and Moving Rocks

Name ____________________ **Date** ____________

7. Which of the following is NOT an example of erosion?

A. river carries sediment

B. man digs a ditch

C. moon causes tides

D. pebble rolls down a hillside

8. Weathering, which breaks rocks into pieces, is caused by ice, water, wind, gases, and ______.

A. soil

B. plants

C. weight

D. sand

9. The agents of erosion include all **except** ______.

A. rock and rock fragments under the influence of gravity

B. currents such as wind, water, or ice flow

C. the breaking down of rock through processes where no movement is involved

D. poor land uses such as deforestation and unmanaged construction

Concept Assessment
Unit 4, Concept 2: Changing Landscapes

Name ______________________________ **Date** ____________________

Instructions
Please answer each question carefully.

1. Water flowing from a garden hose causes the soil to be washed down the hill. This is an example of ______.

A. a deposit

B. a glacier

C. erosion

D. sedimentation

2. A fan-shaped mass of mud and other sediment that forms where a river enters a large body of water is called a ______.

A. canyon

B. delta

C. dune

D. valley

3. Recent storms and heavy rains have flooded a small town. As a result, the nearby river has a high water level and is flowing faster than normal.

Read the following statements. Circle three possible effects that the heavy rain may have on the area.

There will be increased erosion along the riverbanks.

Dunes may be created along the riverbanks.

Rocks, sand, and soil will be swept downstream.

Streams that lead into the river will have increased water flow.

The river delta will be swept away.

Concept Assessment
Unit 4, Concept 2: Changing Landscapes

Name ______________________ **Date** ______________

4. Which is evidence that a glacier causes erosion?

A. a glacier that slowly retreats over time

B. large scrapes on the surface of a glacier

C. snow that is more compacted each year

D. deep cuts in land over which a glacier moves

5. The surface of the Earth is shaped by:

A. ice

B. water

C. wind

D. all of the above

6. Which statement about erosion is TRUE?

A. A river can cut through rock.

B. Earth materials are built up by the process of erosion.

C. Water cannot move heavy rocks.

D. Most erosion happens quickly.

7. Which of the following is most important to the formation of sand dunes?

A. Rocks that fall from a mountain break into small particles.

B. Water keeps the sand at beaches wet so the sand can form dunes.

C. Strong winds carry sand that piles up to form dunes.

D. Glaciers break rock down into sand.

Concept Assessment
Unit 4, Concept 2: Changing Landscapes

Name ______________________ **Date** ______________

8. Most canyons form by erosion. In order for this to happen, what must happen first?

- **A.** Water must move over a rock formation that has soft areas for the water to erode the rock.
- **B.** The land must be in a dry area where there is more water and moisture to loosen the rock.
- **C.** Water must freeze and create cracks for the water to erode the rock.
- **D.** A crack must form in Earth's crust for water to flow into.

9. Glaciers move slowly across Earth's surface. As they do this, soil and rock can collect between the layers of the glacier. What happens to this soil and rock?

- **A.** It causes the glacier to gradually fall apart.
- **B.** It causes the moving glacier to carve away the land.
- **C.** It becomes so hot that it gradually melts the glacier.
- **D.** Over time, the glacier pushes it together to form mountains.

10. A steep-sided valley formed by the erosional force of running water is a:

- **A.** floodplain
- **B.** canyon
- **C.** mesa
- **D.** delta

Unit 3 Concept 1

Concept Assessment
Unit 3, Concept 1: Devices and Energy

Name ______________________ **Date** ______________

Instructions
Please answer each question carefully.

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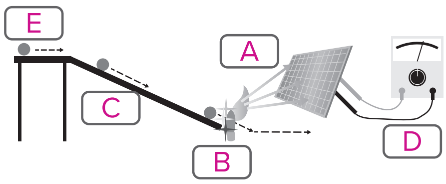
Here is a contraption that shows a ball on a table that rolls down a ramp. The ball strikes a match and the match ignites. The light from the match shines on a photo cell that creates electricity. The photo cell is connected to a meter that measures the voltage of the electricity.



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A. Light
B. Chemical
C. Mechanical
D. Electrical
E. Potential

Concept Assessment
Unit 3, Concept 1: Devices and Energy

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Concept Assessment
Unit 3, Concept 1: Devices and Energy

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A. heat energy
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Unit 3 Concept 2

Concept Assessment
Unit 3, Concept 2: About Fuels

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Instructions
Please answer each question carefully.

1. Ayman has just finished writing his report on fossil fuels. Read it over and help him find FOUR words or phrases that need to be revised because they give INCORRECT information. Circle or highlight the INCORRECT four words or phrases.

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Concept Assessment
Unit 3, Concept 2: About Fuels

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F Drive your own car instead of sharing a car with your friend.

F Use coal instead of solar energy.

F Heat your house to a very warm temperature in the winter.

T Turn off your phone and computer when you are not using them.

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3. Fossil fuels form over millions of years. Put the steps in order to show how fossil fuels form. Order the statements in the column to the left with **1** as the statement that happened first and **5** as the statement that happened last.

2 The plants and animals on Earth get old or sick and die.

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1 The ancient Earth is covered in swamp land where plants and animals thrive.

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Concept Assessment
Unit 3, Concept 2: About Fuels

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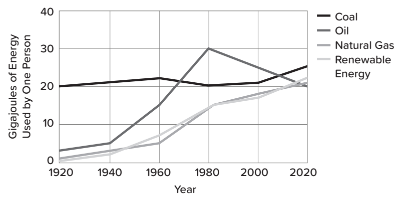
Coal, Oil, Natural Gas, and Renewable Energy



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Concept Assessment
Unit 3, Concept 2: About Fuels

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Renewable I want to use geothermal heat to power my televisions and other electronic devices.

Nonrenewable I want to use wood shipped from another country to build my house.

Nonrenewable I want to use oil to heat my home in the winter and cool it in the summer.

Renewable I want to use wind turbines to provide power for large electrical appliances like my refrigerator.

Renewable I want to use solar energy to heat the water for laundry and bathing.

Nonrenewable I want to use natural gas to provide electricity for lights in my home.

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Concept Assessment
Unit 3, Concept 2: About Fuels

Name ______________________ **Date** ______________

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Concept Assessment
Unit 4, Concept 1: Breaking Down and Moving Rocks

Name ______________________ **Date** ______________

Instructions
Please answer each question carefully.

1. Fast moving water erodes part of the riverbank. When the river slows down, some of the sediment is left in a new place. What is this process of leaving material in a new location called?

- **A.** Deposition
- **B.** Erosion
- **C.** Sediment
- **D.** Conservation

2. When elements of weather, such as wind or water, wear away the surface of a rock, which process is taking place?

- **A.** weathering
- **B.** melting
- **C.** heat and pressure
- **D.** volcanic activity

3. Circle or highlight the five words in the paragraph that could also be used to describe the term "erosion."

As a rock moves from place to place throughout Earth, it can undergo several processes that can change its appearance or chemical makeup. At the surface, different elements like wind or rain may break down and relocate the rock fragments to new locations. Rocks may be transferred to a low-lying area. Over time, layers of sediment build up on top of each other and can solidify to become sedimentary rock. It can even possibly shift them to deeper layers of the earth where they encounter a whole new set of geological processes.

Concept Assessment
Unit 4, Concept 1: Breaking Down and Moving Rocks

Name ______________________ **Date** ______________

4. Landslides are formed by different geological processes. Draw a line to match each step of landslide formation to the geological process that causes it.

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5. Which of the following is classified as chemical weathering?

- **A.** ice breaking rocks
- **B.** elements in the water mixing with rocks, causing a reaction that dissolves parts of the rock
- **C.** tree roots growing into rocks
- **D.** rocks bumping into each other in a fast-moving stream

6. What is the process of moving broken earth materials to a different location?

- **A.** erosion
- **B.** sanding
- **C.** weathering
- **D.** deformation

Concept Assessment
Unit 4, Concept 1: Breaking Down and Moving Rocks

Name ______________________ **Date** ______________

7. Which of the following is NOT an example of erosion?

- **A.** river carries sediment
- **B.** man digs a ditch
- **C.** moon causes tides
- **D.** pebble rolls down a hillside

8. Weathering, which breaks rocks into pieces, is caused by ice, water, wind, gases, and ______.

- **A.** soil
- **B.** plants
- **C.** weight
- **D.** sand

9. The agents of erosion include all **except** ______.

- **A.** rock and rock fragments under the influence of gravity
- **B.** currents such as wind, water, or ice flow
- **C.** the breaking down of rock through processes where no movement is involved
- **D.** poor land uses such as deforestation and unmanaged construction

Concept Assessment
Unit 4, Concept 2: Changing Landscapes

Name ______________________ **Date** ______________

Instructions
Please answer each question carefully.

1. Water flowing from a garden hose causes the soil to be washed down the hill. This is an example of ______.

- **A.** a deposit
- **B.** a glacier
- **C.** erosion
- **D.** sedimentation

2. A fan-shaped mass of mud and other sediment that forms where a river enters a large body of water is called a ______.

- **A.** canyon
- **B.** delta
- **C.** dune
- **D.** valley

3. Recent storms and heavy rains have flooded a small town. As a result, the nearby river has a high water level and is flowing faster than normal.

Read the following statements. Circle three possible effects that the heavy rain may have on the area.

There will be increased erosion along the riverbanks.

Dunes may be created along the riverbanks.

Rocks, sand, and soil will be swept downstream.

Streams that lead into the river will have increased water flow.

The river delta will be swept away.

Concept Assessment
Unit 4, Concept 2: Changing Landscapes

Name ______________________ **Date** ______________

4. Which is evidence that a glacier causes erosion?

- **A.** a glacier that slowly retreats over time
- **B.** large scrapes on the surface of a glacier
- **C.** snow that is more compacted each year
- **D.** deep cuts in land over which a glacier moves

5. The surface of the Earth is shaped by:

- **A.** ice
- **B.** water
- **C.** wind
- **D.** all of the above

6. Which statement about erosion is TRUE?

- **A.** A river can cut through rock.
- **B.** Earth materials are built up by the process of erosion.
- **C.** Water cannot move heavy rocks.
- **D.** Most erosion happens quickly.

7. Which of the following is most important to the formation of sand dunes?

- **A.** Rocks that fall from a mountain break into small particles.
- **B.** Water keeps the sand at beaches wet so the sand can form dunes.
- **C.** Strong winds carry sand that piles up to form dunes.
- **D.** Glaciers break rock down into sand.

Concept Assessment
Unit 4, Concept 2: Changing Landscapes

Name ______________________ **Date** ______________

8. Most canyons form by erosion. In order for this to happen, what must happen first?

- **A.** Water must move over a rock formation that has soft areas for the water to erode the rock.
- **B.** The land must be in a dry area where there is more water and moisture to loosen the rock.
- **C.** Water must freeze and create cracks for the water to erode the rock.
- **D.** A crack must form in Earth's crust for water to flow into.

9. Glaciers move slowly across Earth's surface. As they do this, soil and rock can collect between the layers of the glacier. What happens to this soil and rock?

- **A.** It causes the glacier to gradually fall apart.
- **B.** It causes the moving glacier to carve away the land.
- **C.** It becomes so hot that it gradually melts the glacier.
- **D.** Over time, the glacier pushes it together to form mountains.

10. A steep-sided valley formed by the erosional force of running water is a:

- **A.** floodplain
- **B.** canyon
- **C.** mesa
- **D.** delta

Name ______________________________

T-Chart

Topic ______________________________

Name ______________________________

Claim, Evidence, Reasoning

My Question A question I want to answer	**My Claim** The answer to my question

Evidence I Collected Data and evidence I collected from video, reading, interactives, and hands-on activities	**Reasoning That Supports My Claim** Why my answer is correct

Name ______________________________

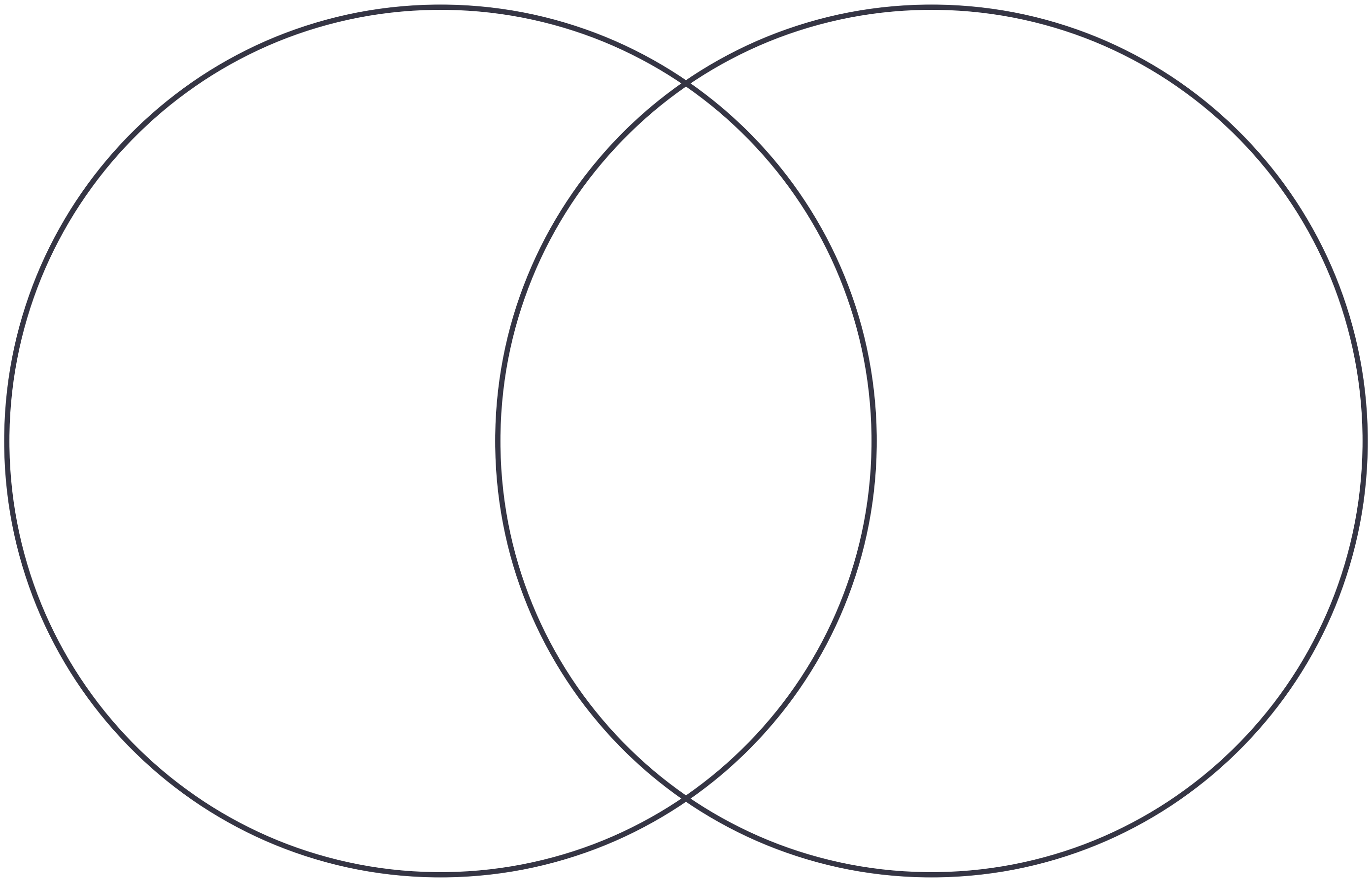
Cause / Effect

Topic ______________________________

Cause | **Effect**

Name ______________________________

Venn Diagram



Following common safety practices is the first rule of any laboratory or field scientific investigation.

Dress for Safety

One of the most important steps in a safe investigation is dressing appropriately.

- Use gloves to protect your hands and safety goggles to protect your eyes when handling chemicals, liquids, or organisms.
- Wear proper clothing and clothing protection. Tie back long hair, roll up long sleeves, and if they are available, wear a lab coat or apron over your clothes. Always wear close-toed shoes. During field investigations, wear long pants and long sleeves.

Safety Goggles

Be Prepared for Accidents

Even if you are practicing safe behavior during an investigation, accidents can happen. Learn the emergency equipment location if available and how to use it.

Most importantly, when an accident occurs, immediately alert your teacher and classmates. Do not try to keep the accident a secret or respond to it by yourself. Your teacher and classmates can help you.

Practice Safe Behavior

There are many ways to stay safe during a scientific investigation. You should always use safe and appropriate behavior before, during, and after your investigation.

- Read all of the steps of the procedure before beginning your investigation. Make sure you understand all the steps. Ask your teacher for help if you do not understand any part of the procedure.
- Gather all your materials and keep your workstation neat and organized. Label any chemicals you are using.
- During the investigation, be sure to follow the steps of the procedure exactly. Use only directions and materials that have been approved by your teacher.
- Eating and drinking are not allowed during an investigation. If asked to observe the odor of a substance, do so using the correct procedure known as wafting, in which you cup your hand over the container holding the substance and gently wave enough air toward your face to make sense of the smell.
- When performing investigations, stay focused on the steps of the procedure and your behavior during the investigation. During investigations, there are many materials and equipment that can cause injuries.
- Treat animals and plants with respect during an investigation.
- After the investigation is over, appropriately dispose of any chemicals or other materials that you have used. Ask your teacher if you are unsure of how to dispose of anything.
- Make sure that you have returned any extra materials and pieces of equipment to the correct storage space.
- Leave your workstation clean and neat. Wash your hands thoroughly.

A

adaptation
a behavior or physical feature that has changed over time to help an organism survive in its environment (related word: adapt)

antenna
a device that receives radio waves and television signals

Arctic
being from an icy climate, such as the north pole

B

behavior
all of the actions and reactions of an animal or a person (related word: behave)

brain
the main control center in an animal body; part of the central nervous system

C

camouflage
the coloring or patterns on an animal's body that allow it to blend in with its environment

canyons
deep valleys carved by flowing water

chemical energy
energy that can be changed into motion and heat

chemical weathering
changes to rocks and minerals on Earth's surface that are caused by chemical reactions

code
information transformed into another, representative, form (such as using dots and dashes to represent letters)

collision
the moment where two objects hit or make contact in a forceful way

convert (v)
to change forms

D

delta
a fan-shaped mass of mud and other sediment that forms where a river enters a large body of water

deposition
laying sediment back down after erosion moves it around

digestive system
the body system that breaks down food into tiny pieces so that the body's cells can use it for energy

digital
a signal that is not continuous and is made up of tiny separate pieces

dune
a hill of sand created by the wind

E

Earth
the third planet from the sun; the planet on which we live (related words: earthly; earth – meaning soil or dirt)

earthquake
a sudden shaking of the ground caused by the movement of rock underground

electromagnetic spectrum
the full range of frequencies of electromagnetic waves

energy
the ability to do work or cause change; the ability to move an object some distance

energy conservation
to use energy wisely in order to prevent the wasteful overuse of resources

energy efficiency
reducing the amount of energy needed to perform a task

energy source
where a form of energy begins

energy transfer
the transfer of energy from one organism to another through a food chain or web; or the transfer of energy from one object to another, such as heat energy

engineer
Engineers have special skills. They design tools or technologies that help solve problems.

erosion
the removal of weathered rock material. After rocks have been broken down, the small particles are transported to other locations by wind, water, ice, and gravity.

erupt
the action of lava coming out of a hole or crack in Earth's surface; the sudden release of hot gasses or lava built up inside a volcano (related word: eruption)

extinct
describes a species of animals that once lived on Earth but which no longer exists (related word: extinction)

F

feature
things that describe what something looks like

force
a pull or push that is applied to an object

forecast
(v) to analyze weather data and make an educated guess about weather in the future; (n) a prediction about what the weather will be like in the future based on weather data

fossil fuels
fuels that come from very old life forms that decomposed over a long period of time, like coal, oil, and natural gas

friction
a force that slows down or stops motion

fuels
any materials that can be used for energy

G

generate
to produce by turning a form of energy into electricity

geothermal
heat found deep within Earth

glacier
a large sheet of ice or snow that moves slowly over Earth's surface

gravitational potential energy
energy stored in an object based on its height and mass

H

heart
the muscular organ of an animal that pumps blood throughout the body

heat
the transfer of thermal energy

hibernate
to reduce body movement during the winter in an effort to conserve energy (related word: hibernation)

I

information
facts or data about something; the arrangement or sequence of facts or data

K

kinetic energy
the energy an object has because of its motion

L

lava
molten rock that comes through holes or cracks in Earth's crust that may be a mixture of liquid and gas but will turn into solid rock once cooled

light
a form of energy that moves in waves and particles and can be seen

M

magma
melted rock located beneath Earth's surface

magnetic field
a region in space near a magnet or electric current in which magnetic forces can be detected

mass
the amount of matter in an object

matter
material that has mass and takes up some amount of space

mechanical weathering
breaking down of rocks due to physical factors (as opposed to chemical factors)

migration
the movement of a group of organisms from one place to another, usually due to a change in seasons

minerals
natural, nonliving solid element that makes up rocks

model
a drawing, object, or idea that represents a real event, object, or process

motion
when something moves from one place to another (related words: move, movement)

N

nerve
a cell of the nervous system that carries signals to the body from the brain, and from the body to the brain and/or spinal cord

nonrenewable
once it is used, it cannot be made or reused again

nonrenewable resource
a natural resource of which a finite amount exists, or one that cannot be replaced with currently available technologies

O

ocean
a large body of salt water that covers most of Earth

opaque
describes an object that light cannot travel through

organism
any individual living thing

P

pollute
to put harmful materials into the air, water, or soil (related words: pollution, pollutant)

pollution
when harmful materials have been put into the air, water, or soil (related word: pollute)

potential energy
the amount of energy that is stored in an object; energy that an object has because of its position relative to other objects

predator
an animal that hunts and eats another animal

predict
to guess what will happen in the future (related word: prediction)

prey
an animal that is hunted and eaten by another animal

pupil
the black circle at the center of an iris that controls how much light enters the eye

R

radiation
electromagnetic energy (related word: radiate)

receptor
nerves located in different parts of the body that are especially adapted to receive information from the environment

reflect
light bouncing off a surface (related word: reflection)

reflex
an automatic response

renewable
to reuse or make new again

renewable resource
a natural resource that can be replaced

reproduce
to make more of a species; to have offspring (related word: reproduction)

resistance
when materials do not let energy transfer through them

rock cycle
the process during which rocks are formed, change, wear down, and are formed again over long periods of time

S

sediment
solid material, moved by wind and water, that settles on the surface of land or the bottom of a body of water

seismic
having to do with earthquakes or earth vibrations

senses
taste, touch, sight, smell, and hearing (related word: sensory)

soil
the outer layer of Earth's crust in which plants can grow; made of bits of dead plant and animal material as well as bits of rocks and minerals

sound
anything you can hear that travels by making vibrations in air, water, and solids

sound wave
a sound vibration as it is passing through a material; most sound waves spread out in every direction from their source

speed
the measurement of how fast an object is moving

stomach
a muscular organ in the body where chemical and mechanical digestion take place

sun
any star around which planets revolve

survive
to continue living or existing: an organism survives until it dies; a species survives until it becomes extinct (related word: survival)

system
a group of related objects that work together to perform a function

T

tectonic plate
one of several huge pieces of Earth's crust

thermal energy
energy in the form of heat

trait
a characteristic or property of an organism

transparent
describes materials through which light can travel; materials that can be seen through

turbine
a machine designed to spin in a stream of moving water, steam, or wind that is often used in generating electricity

V

valley
a low area of land between two higher areas, often formed by water

volcano
an opening in Earth's surface through which magma and gases or only gases erupt (related word: volcanic)

W

water
a compound made of hydrogen and oxygen; can be in either a liquid, ice, or vapor form and has no taste or smell

watermills
structures that use a turbine or water wheel to harness the kinetic energy of moving water to operate machinery or as a step in the generation of electricity

wave
a disturbance caused by a vibration; waves travel away from the source that makes them

weathering
the physical or chemical breakdown of rocks and minerals into smaller pieces or aqueous solutions on Earth's surface

windmills
structures that use blades placed at an angle around a fixed point to convert the kinetic energy of wind into energy that can operate machinery or generate electricity

work
a force applied to an object over a distance

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Unit 3

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